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CONTENTS

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AGRICULTURAL ENGINEERING

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"Flood Control at the Grass Roots"

"REARRANGEMENTS of the face of a land, such as are required for civilized occupation and the pursuits of modern agriculture and industry, make inevitable, I suppose, an increased runoff of water and of sediment. . . . . For all of our advancing devices and increasing expenditures to control running water, we are a long way from achieving complete control. One reason for this is that we have never really tackled the problem as a whole. What we need, I think, is a coordinated and interdependent approach which will treat the whole water system, from the crest of the hills right down to the mouth of the rivers."

So said Secretary of Agriculture Henry A. Wallace to the National Rivers and Harbors Congress on April 27, under the title above quoted. He told how the March floods lay good farm land four inches deep in the streets of Washington, cited his observations as to runoff and soil losses in the vicinity of Ithaca, New York, where he happened to be at the time of rains totalling five inches, and quoted a few striking findings of the soil erosion control stations from the many which during the years have been reported in these pages by C. E. Ramser and others. He did not dwell on terracing as such, neither did he slight it as among the measures to be taken "at the grass roots," his emphasis being more on place than on method.

We may be grateful to Secretary Wallace, not merely as an able spokesman for agriculture, including agricultural engineering, but as a statesman dealing in terms of the whole national welfare. As one of our own ASAE past-presidents (Fletcher) pointed out some years ago, we all have been thinking too much in terms of the part, and not sufficiently organizing our thinking and our procedures in terms of the whole. We may well follow the example of Mr. Wallace, not merely in working out ways and means to dovetail agriculture's problems into national policy, but of selling vigorously the wisdom of such procedure to other groups whose interests overlap those of agriculture.

ASAE and AEC

AS A MATTER of academic knowledge, every member of the American Society of Agricultural Engineers is aware that our Society is a member of American Engineering Council. But from the very fact that AEC is an organization of organizations, it probably is also true that few of us have any great consciousness of what AEC means to us individually, or even what are its objectives and what have been its achievements. This is not the place, even if space permitted, to discuss such matters in detail. A concise statement of the AEC organization and of its current agenda appeared on page 121 of AGRICULTURAL ENGINEERING for March.

Rather, this is an attempt to reflect the editor's personal feeling, based on continued contact with the activity of AEC, and on occasional contact with its staff personnel—a confession of faith. That feeling, built up slowly and steadily, is a composite of many elements and innumerable details that defy summary. Looking back on the recent years, when every element of expense was a challenge to Society policy, it is our judgment that the sustained participation of ASAE as a member of AEC was eminently wise. With even more official significance, this is also the feeling of the ASAE representatives on AEC and other members who have had close contacts with that organization, including President Livingston and Past-Presidents Fletcher and Trullinger. In simple fairness it should be added that they have discharged their duties in a fashion that commands the respect of the other engineering bodies, and does credit to our branch of the engineering profession.

Two phases of American Engineering Council's activity may be singled out for mention because they fortify purposes which have been emphasized in the ASAE. One is what we have called human engineering, or the conscious advancement of human well-being, in all ranks and capacities, in ways that are technically sound and economically efficient. The AEC study and findings on the twelve-hour day are a classic example.

The other has to do with engineering participation in matters of public policy. Not only does AEC maintain the machinery to facilitate such leadership, but by presenting an integrated front for more than forty branches of engineering, as represented by national bodies, adds much of prestige in whatever sector of subject matter may be involved. To a greater extent than is superficially apparent, the increasing authority of engineers in public affairs is due to the correlating, unifying work of AEC.

Power Alcohol Again

TWO THINGS now bring the power alcohol issue into the limelight once more. One is its discussion at the Second Dearborn Conference sponsored by the Farm Chemurgic Council. The other is the assured creation of a power alcohol plant in Kansas backed and (we understand) underwritten by the Chemical Foundation.

The impression has prevailed that the petroleum industry is opposed to alcohol as a motor fuel, or as an ingredient therein. As the lone representative of petroleum at the Dearborn Conference, Mr. Fred A. Eldean, speaking for the American Petroleum Institute, stated that "the oil industry was not opposed to blended fuel as such, but that it

did oppose persistent efforts to make blended fuels compulsory, either directly or through subsidies or tax differentials. . . . . If alcohol as a motor fuel has the qualities claimed for it and can be sold at economic prices, then the obvious thing to do is to go out and market it."

In the course of the alcohol session of the Conference evidence was adduced that the oil industry is doing precisely that; not in America, but (through foreign ramifications of sundry companies) in at least one land where gasoline is called petrol and carbon removal goes by the happier term of decoking. This, be it noted, is a country which has no such agricultural "surplus" problem as ours, but where the alcohol, or its raw materials, must be brought from overseas. Nevertheless, there is economic pressure back of the alcohol blends, involving higher prices for petrol, high displacement taxes on motor vehicles, and consequent demand for superior performance, both as to specific power and per-mile economy.

Despite our natural and avowed protagonism of agriculture, we believe most agricultural engineers join us and the petroleum industry in feeling that power alcohol should find its place in the scheme of things by its own technical and economic merit; that it should not be crammed down the throats of the American people by compulsory enactment or discriminatory taxation. We go not quite so far as the petroleum spokesman; we do not necessarily rule out subsidy.

In the American system there has been a place for special encouragement of "infant industries," and we believe that the principle is sound, even if it has at times been abused. If we are correctly informed, the production of alcohol is notably an industry in which costs are greatly affected by the scale of operation. Therefore, to determine the economics of power alcohol it probably will be necessary to have at least one full-size commercial unit in operation. Further, because the question involves distribution facilities as a major factor, and possibly also the design of engines, such a commercial-size unit should be set up with an assured period of operation long enough to justify the purchase of engines and the enlistment of adequate marketing agencies. There must be a test area with an adequate number of test consumers as well as an experimental production plant.

For such a period of time, and in such a limited but adequate area, we submit that subsidy may be permissible. It should be regarded and conducted, not as a coup to force a change in our power sources, but as research and demonstration to find out whether or not such change is economically feasible. Whether favorable or otherwise to alcohol, the findings should be worth all that they cost. It would appear that the Chemical Foundation's sponsorship of the alcohol plant above-mentioned is a courageous step toward such a test program. It deserves, and quite possibly may need, additional support from other sources.

If agriculture were, like other industries, organized in large units on a corporate basis, with well-oiled trade associations, such a test and demonstration program might properly be assigned to private initiative. As things stand, the man who rides the tractor is not fitted to conduct or cooperate in an efficient research project of this magnitude. If the interest of agriculture is to be adequately represented, there must be recourse to public agencies.

Our reason for proposing direct subsidy rather than indirect encouragement such as discriminatory taxation is simple. It is far easier to withdraw a subsidy after it has served its need than it is to repeal or reduce a tax. Moreover, a test program for the guidance of the whole nation should be financed by the nation at large rather than assessed against the test area. The administration of research funds, even in the form of subsidy, is likely to be far more sound and logical than the machinations that surround tax policies.—W. B. JONES

Engineering the Artichoke

WITHOUT presuming to appraise its promise, one of the most interesting things thus far done by the Farm Chemurgic Council, in our view, is its advocacy of an artichoke research institute. This is one of several directions of research which the chemurgists believe can be pursued most effectively by setting up "institutes" on a regional, commodity, or project basis. Our present interest, however, is not in the method but in the crop.

In the light of our meagre knowledge it would seem that the possibilities of the artichoke have not been explored, much less realized, mainly because of certain problems whose solution lies within the domain of agricultural engineering. One of these is storage, which seems to be an impossibility under ordinary farm storage conditions. If and when feasible storage conditions are defined, our farm structures engineers will have the challenge of creating those conditions at costs consistent with the economic value of the crop.

Tillage and planting probably will present no great difficulties, but harvesting and cleaning promise to call for methods and machinery almost wholly new to the experience of farming and farm machinery manufacture, if the results are to be both effective and economical. Because of the high water content, transportation will present a problem akin to that of the cane fields, but in the agricultural pneumatic tire we have a tool that should meet the challenge.

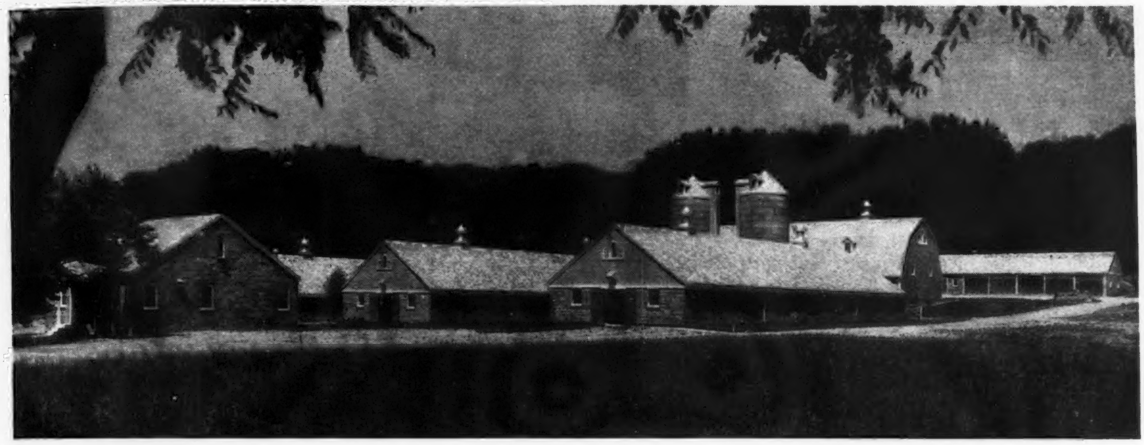
Besides its value in the production of alcohol, sugars, and other chemico-industrial products as envisioned by the chemurgists, the artichoke may have other values for the farmer and agricultural engineer. Its rank as to hardiness in the face of heat, cold, and drought, plus its rankness of growth, may make it a weapon for fighting wind erosion in some conditions. In a field where the agricultural engineer has been not too successful, that of weed control, the artichoke may have value. We have been told by practical farmers that they have completely choked out areas of quack grass by letting artichokes take possession.

This, of course, raises the question of eradicating the artichokes, but we are given to understand that a drove of hogs is the natural, easy, and even profitable answer; indeed, that to a limited extent artichokes are worthwhile for their own sake as a hogging-down crop. Even when grown primarily for industrial use, gleaning by hogs probably will be a part of efficient management, and this in turn involves fencing, another responsibility of the structures engineer.

To the agronomist, and to the conservation-minded engineer, any high-tonnage crop immediately presents a question as to depletion of fertility. We suggest that this be measured early in the investigation of the artichoke, and that any proposals for artichoke growing be developed and evaluated subject to the requirement that plant food reserves shall be maintained or augmented.

New Things in Concrete Construction for Farm Application

By W. G. Kaiser



A MODERN MARYLAND DAIRY PLANT

AT THE 1934 annual meeting of the American Society of Agricultural Engineers in Detroit it was my privilege to present a paper on the subject of concrete joist floors. At that time the concrete joist type of floor had not progressed much beyond the experimental stage. It is now well established. More than 120 concrete products manufacturers have installed molds and other equipment for casting joists. Upward of 1,000 floors of this type were built in 1935. These floors have, for the most part, been placed in residences and in other buildings with relatively light loadings, that is, loadings up to 100 or 150 pounds per square foot. This would include practically all floors in farm buildings with the exception of floors supporting grain storage bins. Concrete joist floors, of course, can be designed to carry any required load by increasing depth of joist or by closer spacing. For loads exceeding 150 pounds per square foot it is doubtful, however, if they offer any economies over other standard types of concrete floors. It is in the residence and farm building field that they are particularly adaptable. They offer a practical solution to the problem of reducing the hazards of farm fires. This type of floor also offers an economical solution to the problem of building firesafe hay loft floors.

The majority of concrete joist floors have been built with job-placed concrete slabs; the slab bonding to the head of the joist and embracing it to a depth of ½ inch. This bond is essential to develop the proper interaction between the slab and the joist so that the two may act as a T-beam. Tests made by the Portland Cement Association development department and at Michigan State College definitely prove that T-beam action is developed and that concrete joist floors can safely be designed with T-beam formulas.

A more recent development is the use of precast concrete slabs or planks. More than 100 houses in the Tennessee Valley Authority housing project near Norris, Tenn., have floors in which both the concrete joists and slabs were precast. Slabs in this case were approximately 30 inches square and 2 inches thick. The Southern Cast Stone Company of Knoxville, Tenn., which made the joists and slabs for the TVA project developed some novel features of construction which contributed materially to the practicability of this construction. Joists were made with mortar grooves on the top. Slabs were made with concave edges, interposed with lugs, which facilitated the placing of steel in the joints. The effect of the grooves, concave edges and lugs is to prevent movement once the slabs are placed and the joints grouted.

The development department of the PCA recently concluded a series of tests to determine the strength of the bond between the precast slabs and joists to see whether floors so assembled could be designed as T-beams. In the case of the TVA floors the concrete joists were designed as simple beams to carry the entire live and dead weight of the floor. To secure proper T-beam action it is necessary to develop a strong bond between slabs and joists. The PCA tests included a study of several types of joints. Floor sections 14 to 20 feet long by 4 feet and 8 feet wide were built and loaded until failure occurred at the bond or other part of the construction. Other variables in these tests included study of composition and strength of the mortar, type of aggregate and roughness of the bonding faces.

The panels built with precast slabs 4 feet long by 1 foot wide by 2 inches thick and bond joint type 1 which had plain bonding faces gave the poorest results; the joint rupturing with superimposed loads of 40 to 160 pounds per square foot. Results in this group, as might be expected, were greatly affected by the texture of the bonding faces. The rough finished surfaces produced strengths up to four times that obtained with smooth surfaces.

In bond joints B and C, slab type 1, a mechanical bond

Presented before the Farm Structures Division of the American Society of Agricultural Engineers at Chicago, December 2, 1935.

Author: Manager, cement products bureau, Portland Cement Association.

was obtained and load capacities were greatly increased. Panels with bond joint B failed with superimposed loads ranging from 278 to 288 pounds per square foot; with bond joint C, 218 to 285 pounds per square foot. Where the ultimate load exceeded 240 pounds per square foot, failure generally was due to a tension or bond failure of the joist reinforcement. In bond joint B there were no joint failures at ultimate loads.

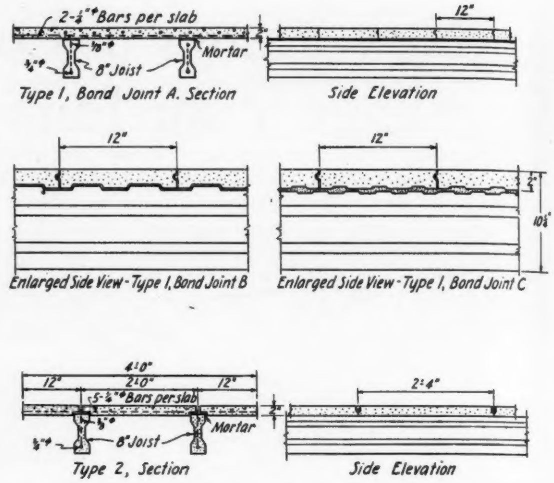
Satisfactory results likewise were obtained with the panels using type 2 slab. Failure occurred with loads of 280 pounds per square foot. In these panels the shear reinforcement in the joists consisted of looped stirrups, the loop projecting about one inch above the joists. The embedment of this loop in the mortar fill added substantially to the joint strength.

PRECAST CONCRETE RAFTERS

Another recent adaptation of precast members is that of roof rafters. The concrete joists or rafters are laid to a pitch as are wood or steel rafters. The ends are butted to shoulders on top of the outside walls with tie rods running from wall to wall to prevent possible spreading. The ridge is blocked in with concrete. Precast concrete slabs are laid over the rafters to which they are bonded with mortar. Where cinder aggregates are used in making the sheathing slabs various roof coverings can be nailed directly to the slabs. Flat roofs can be of concrete joist and slab construction following same principles of construction as concrete joist floors. They are usually covered with standard 3-ply tar and gravel roof to insure watertight construction.

CONCRETE ASHLAR

Concrete ashlar is not in itself new, but its possibilities appear to have received scant recognition until the last few years. Concrete ashlar consists of concrete masonry units laid up in regular courses or in random pattern. Units



PRINCIPAL DETAILS OF SLAB TYPES 1 AND 2, AND BOND JOINTS

of several sizes are usually employed, all of which are some multiple of 4 inches for ease in fitting and laying. Exterior wall surfaces are generally given two coats of portland cement paint in any color desired. This paint application serves to weatherproof the surface yet is not heavy enough to hide the joint markings which, though subdued, remain visible resulting in an interesting wall surface. Additional character is given the wall by varying the texture from fine to coarse as the architectural treatment requires. The question arose as to just how coarse a texture could be used and still be able to build a weathertight wall with the usual application of two coats of portland cement paint. To find the answer to this problem the PCA development de-

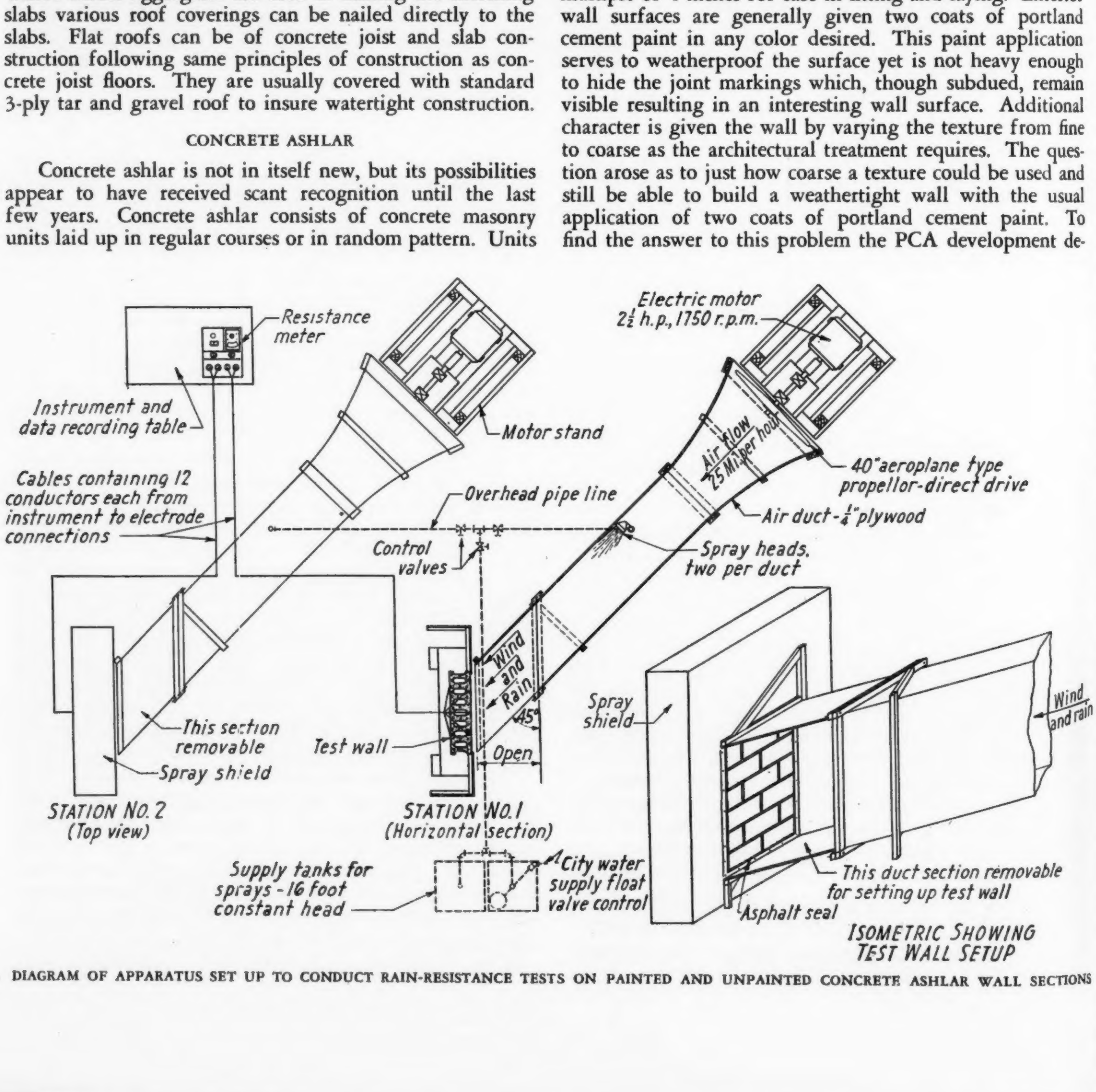
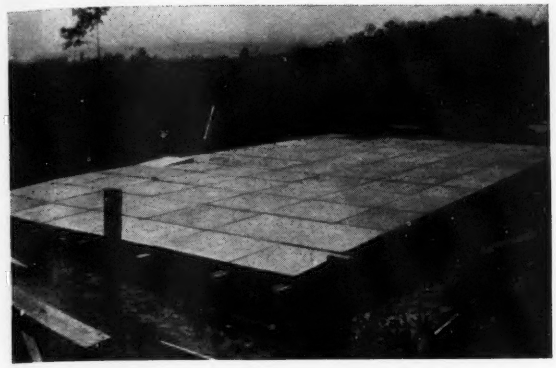


DIAGRAM OF APPARATUS SET UP TO CONDUCT RAIN-RESISTANCE TESTS ON PAINTED AND UNPAINTED CONCRETE ASHLAR WALL SECTIONS



FIRST-FLOOR CONCRETE JOIST AND SLAB CONSTRUCTION STARTED ON A SMALL FARM BUILDING

partment is completing a series of tests which indicate that two coats of paint will effectually seal the surface.

This research was conducted for the purpose of determining the resistance to rain penetration of a wide range of types of concrete masonry construction.

Wall leakage is not a problem peculiar to concrete masonry walls. All types of masonry have given trouble in this respect in areas subject to hard, driving rains.

Most tests of this kind have been made with static hydraulic head or with a water spray directed from a nozzle. It is difficult if not impossible to apply the results of such tests to the performance of a wall subjected to a heavy rain combined with a driving wind. For this reason special apparatus was built to produce wind and rain conditions similar to those on walls which are subjected to actual use.

The apparatus consisted of an air tunnel with the test wall erected at one end and an airplane type propeller directly connected to an electric motor at the other end. About midway between the propeller and the test wall, sprayheads were placed so as to discharge rain-size particles of water at a known rate into the air stream.

The velocity of the air stream was 25 miles per hour and the rain intensities used were 2½ inches of rain per hour for the first 12 hours of test and 12 inches per hour for the next 12 hours. The air velocity and rain intensity were carefully calibrated and checked from time to time.

The endurance period was based on the time required for water to penetrate first to the core spaces and then to the unexposed face. To eliminate the personal element in judging when failure occurred, the moisture condition of the concrete was determined at frequent intervals during the test by means of electrical resistance. Pairs of copper strips were attached to the surface of the concrete within the core spaces and on the unexposed face. An electrical current of known voltage was passed through the circuit and the resistance of the concrete in the areas between each pair of electrodes read on an ohmmeter.

At the beginning of the test this resistance of the concrete, being dry, would be one or two million ohms. But when moisture penetrated the face shells the circuits leading to the electrodes placed in the cores would show a sharp decrease in the electrical resistance of the concrete and it was known that moisture was coming through.

The walls which had the exposed face painted offered much greater resistance to rain penetration than unpainted walls and for these a 24-hour continuous test was used. Many of the painted walls effectively resisted failure for this period during which they were subjected to 174 inches of water hurled against the wall face by a 25-mile-per-hour wind.

It was found that the best results were obtained by applying the two coats of portland cement paint with a brush having short stiff fiber bristles. Good workmanship is essential to insure that the entire surface is effectively covered and all surface voids filled. Sprayed-on coatings were less watertight than brushed-on coatings under the conditions employed in these tests. Paint used in these tests was mixed in the proportion of 1.6 pounds of portland cement to 1 pound of water for brush application. Paint to be sprayed on was mixed in the ratio of 2 pounds of cement to 1 pound of water.

Oregon Receives Historic Tile

DR. W. L. POWERS, (Mem. ASAE), soil scientist, Oregon State Agricultural College, reports that he received recently a historic drainage tile from Ed Clements, of the USDA Soil Conservation Service.

The tile, which is nearly 150 years old, was recovered from the site of an old mission, La Purisima, at Lompoc, California. The mission was started in 1787, destroyed by an earthquake in 1812, and never rebuilt on the same site. Parts of the destroyed mission were used in rebuilding on a site about four miles from the original one. Drain tile were used there too, in a water system which was a marvel of ingenuity for that period. Three separate springs were drained by tile pipes and a tile-lined conduit which carried water more than a mile to the fountain basin in front of the mission.

The tile is 21 inches long, conical in shape, with well formed walls about ¾ inch thick, and an inside diameter of 2½ inches. It is made for laying with the end of one joint fitted into the end of the next. The shape of individual joints varies due to their being made by hand. The joints received were well burned and are still sound and strong.

THE TALLEST TILE IN THIS GROUP IS THE ONE FROM THE OLD MISSION. THE HEXAGONAL TILE IS 70 YEARS OLD, AND THE SHORT CONCRETE TILE SHOWS EFFECTS OF 7 YEARS IN SOIL WITH A LIME REQUIREMENT OF FOUR TONS PER ACRE. THE OTHERS ARE STANDARD CONCRETE AND CLAY TILE

Effective Diameter of Well Network

By Willard Gardner and T. R. Collier

IN A PREVIOUS paper[1,2] the term "effective diameter" of a well battery consisting of a circular array of small wells has been defined and a method presented for computing it in terms of the fundamental elements of the battery, the assumption being made that the flow is two-dimensional. An attempt is made here to extend the analysis to the case of a network of more general character. On the basis of the previous definition, the network and the equivalent single well should each produce the same flow Q with the same lift H' and their piezometric surfaces should come together at infinity.

If friction in the vertical and horizontal interconnecting pipes is neglected, it may be assumed that the water is lifted from the same depth in all the wells of the network, the quantity of flow q_{ij} from well ij being determined, however, on the fundamental basis of Darcy's law by the parameters of the network. It is evident that the location of an individual well in the network will require two coordinates (appropriately polar coordinates) and the subscripts ij will serve therefore to identify this individual well.

Introducing the notation,

$$c_{ij} = q_{ij}/(2\pi l k \rho g), \qquad [A]$$

in which l represents the thickness of the water-bearing stratum, k the transmission constant of the gravel, and ρ the density of the fluid, we may express the Darcy law for well ij thus,

$$h_{ij} - h_{ij}' = c_{ij}\ ln\ (R_{ij}/r_{ij}). \qquad [1]$$

In this equation R_{ij} is the distance from the axis of the well ij to the random point whose polar coordinates are R, θ; r_{ij} is the radius of the well, h_{ij} and h_{ij}' are the respective elevations from an appropriate datum plane of these two points on the piezometric surface that would be determined by this well operating independently.

Inasmuch as the potentials (represented by these elevations) superpose, the elevation h at the random point R, θ of the resultant piezometric surface for the network will represent the summation of these individual differences, and may be expressed,

$$h = \Sigma(c_{ij}\ ln\ [R_{ij}/r_{ij}]). \qquad [2]$$

At the point whose distance is r_{ij} from the axis of well ij, the elevation h_β (the same for all the wells) may be written,

$$h_\beta = \Sigma(c_{ij}\ ln\ [R_{ij}/r_{ij}])_\beta. \qquad [3]$$

The equation of the piezometric surface of the single well equivalent to the network may be written,

$$H = C\ ln\ (R/R_e) + h_\beta, \qquad [4]$$

where $C = \Sigma c_{ij}$, [B]

and where R_e represents the radius of the equivalent well.

It may be observed that for values of R_{ij} which are large compared with the distance of the wells from the origin (which is taken as the center of the network), these values of R_{ij} approach the magnitude R. If, therefore, we impose the condition that these two piezometric surfaces shall meet at infinity, we obtain the relation

$$C\ ln\ R - C\ ln\ R_e + \Sigma(c_{ij}\ ln\ [R_{ij}/r_{ij}])_\beta$$
$$= \Sigma(c_{ij}\ ln\ [R/r_{ij}]). \qquad [5]$$

By an obvious expansion this equation becomes

$$C\ ln\ R - C\ ln\ R_e + ln\ \Pi(R_{ij}/r_{ij})_\beta^{c_{ij}}$$
$$= C\ ln\ R + \Sigma(c_{ij}\ ln\ [1/r_{ij}]), \qquad [5']$$

and reduces finally to

$$R_e = \Pi(R_{ij})_\beta^{c_{ij}/C}, \qquad [6]$$

the right-hand member representing the weighted geometric mean distance of the point β to the axes of the individual wells of the network.

It is to be observed in particular that, if the wells are so distributed as to make the various q_{ij} (and therefore also the c_{ij}) all equal, equation [B] reduces to,

$$C = nc_{ij}, \qquad [B']$$

and equation [6] becomes

$$R_e = (\Pi[R_{ij}]_\beta)^{1/n}, \qquad [6']$$

in which n represents the total number of small wells in the network.

Contribution from Department of Physics, Utah Agricultural Experiment Station. Publication authorized February 29, 1936. First publication in AGRICULTURAL ENGINEERING.

Authors: Respectively, physicist and graduate assistant, Department of Physics, Utah Agricultural Experiment Station.

[1] "Computing the Effective Diameter of a Well Battery by Means of Darcy's Law," by Orville L. Eliason and Willard Gardner, AGRICULTURAL ENGINEERING, vol. 14, no. 2, February 1933.

[2] "Groundwater, Part I, Fundamental Principles Governing Its Physical Control," by Willard Gardner, T. R. Collier, and Doris Farr, Utah Agricultural Experiment Station Bulletin 252 (Technical).

New Sand Trap to Clean Irrigation Water

A VORTEX-TUBE sand trap, consisting of a battery of 12 tubes, has been designed by R. L. Parshall, of the USDA Bureau of Agricultural Engineering, for installation in the West Side Main Canal of the Imperial Irrigation District at Imperial, California. The sand trap will reduce the amount of silt and sand that enters the canal. It will be built in the large wooden flume over New River in Mexico.

The bedload of sand and gravel traveling down the channel will be caught by the whirling waters inside the tubes and will be conveyed to a discharge outlet in the wall of the flume at the floor line.

Vortex-tube sand traps have been installed in a number of relatively swift flowing channels in Colorado, and are proving satisfactory.

Not only does the accumulation of sand and gravel in an irrigation canal affect the accuracy of measurements of flow of water, through deposition of bars, but it also adds greatly to the cost of operation and maintenance because it necessitates more frequent cleaning by dredging or otherwise. When the silt carried in the canal is deposited in great quantities upon irrigated lands, it destroys crops and injures the land.

The Tractor Fuel Situation in Kansas

By E. L. Barger

AS A PART of tractor fuel investigations at the Kansas Engineering Experiment Station there has been conducted a survey of the tractor fuel situation in Kansas. As one of the leading states in numbers of tractors on farms and probably the leading state in total power available from farm tractors, Kansas is favorably situated for a study of this type. The purposes of the survey were to obtain information on the fuels being used and the relative importance of each, and to obtain a record of the tractor owner's experiences in dealing with the fuel problem. In view of the general scarcity of information on this phase of the tractor fuel problem, it is believed that agricultural engineers will be interested in the results obtained.

Since the data presented are based chiefly on estimates and opinions of individuals without technical background, they should not be used to draw conclusions except of a broad or general nature.

The names and addresses of several thousands of tractor owners were obtained from tractor manufacturers and from county agricultural agents throughout the state. During a period between June, 1932, and February, 1935, 2,762 questionnaires, listing questions pertinent to the problem, were sent out, and in all 1,005 acceptable reports were returned. This represents about 1.5 per cent of the tractors in Kansas. Two hundred and nine reports were obtained in 1932 from tractor owners whose names were furnished by the manufacturers. The remainder, 796, representing names furnished by county agents, were obtained in 1934 and 1935.

The accompanying map of the state of Kansas shows the distribution of the tractors involved in the survey. This follows generally the distribution of tractors in the state as determined by assessors' data. It will be noticed that the conventional type of tractor predominates in the western half of the state. This is the main wheat-producing area. The general-purpose tractor is found in larger numbers in the eastern half of the state where the farms are smaller, the topography rougher, and row crops more extensively grown.

Types of farms on which the tractors were being used were as follows: general, 82.9 per cent; grain, 15.5 per cent; livestock, 1.2 per cent; and orchard, 0.4 per cent.

The number of cultivated acres per tractor ranged between 40 and 2400, with an average of 425 acres. This includes land tilled by animal power on farms where both tractors and horses or mules were used.

The average rating of the 1,005 tractors was: drawbar, 17.2 horsepower, and belt, 28.5 horsepower.

Ages of the tractors involved in the survey ranged from 6 months to 20 years. The average age was 5.0 years.

Of the tractor owners, 96.8 per cent reported they were satisfied with their present machines and would replace them, when worn out, with other tractors. The remaining 3.2 per cent were not satisfied and indicated they would replace their tractor with horses. Of the 3.2 per cent dissatisfied, representing only 30 owners, 19 used gasoline; 4, kerosene; and 7, distillate as fuel.

Of the 1,005 tractors on which reports were obtained, 88.6 per cent were equipped to burn a wide range of fuels, including the gasolines, kerosene, and distillates or high-grade fuel oils. In other words, this percentage of tractors were equipped with engines of sufficiently low compression, heated manifolds or manifold heat controls, and the necessary fuel tanks and connections to handle the low-grade fuels.

The farmers were asked to indicate the fuel used each season of the year. Table 1 shows the percentage using each class of fuel in spring, summer, fall, and winter work.

TABLE I. RELATIVE IMPORTANCE OF FUELS BY SEASONS

Season	Number reporting	Per cent using gasoline	Per cent using kerosene	Per cent using distillate
Spring	996	73.8	5.9	20.3
Summer	1004	67.6	7.9	24.5
Fall	1002	70.7	7.0	22.3
Winter	982	82.9	4.3	12.8

The preference for gasoline is outstanding. This situation exists in spite of the fact that over 85 per cent of the tractors in use in the state are equipped with low-grade fuel

Contribution No. 78 from the department of agricultural engineering, Kansas State College, and released for first publication in AGRICULTURAL ENGINEERING.

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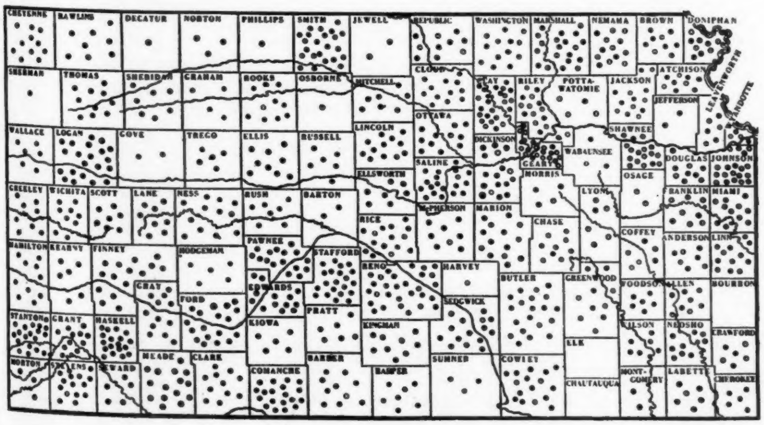


DISTRIBUTION OF TRACTORS INVOLVED IN THE SURVEY. EACH DOT REPRESENTS ONE CONVENTIONAL TYPE TRACTOR AND EACH CIRCLE REPRESENTS A GENERAL-PURPOSE TRACTOR

engines. It is also contrary to the fact that performance and fuel economy are improved when the high-grade fuels are burned in engines designed for their use. The place of the spark-ignition, low-grade fuel-burning engine on the farm is not questioned and to date its economies when low-grade fuel is used have not been disproven. The point open to criticism is that the average farmer is sold a tractor primarily equipped to burn low-grade fuels, even though he intends to and does burn gasoline throughout the tractor's life.

Distillate is in more general use than kerosene. This is due, no doubt, to the relatively high price of kerosene. Also, since kerosene is primarily a lamp oil, it does not always give performance equal to many of the power distillates now available.

Of the tractor operators using gasoline, 72.7 per cent used a low or third-grade gasoline, 27.1 per cent used a regular grade, and 0.2 per cent used premium grade. Low octane gasoline is not objectionable in the average tractor engine because of its low-compression pressure. Even the fact that the third-grade gasolines are less volatile does not handicap them as a tractor fuel, and due to high manifold temperatures, third or low-grade gasoline may be more desirable than the higher grade gasoline. The general satisfaction with low-grade gasolines is indicated by the large majority of tractor operators using that grade of fuel.

The importance of gasoline as a fuel in Kansas tractors is shown with greater emphasis when the comparison is made on a volume basis. The average quantity of all fuels consumed yearly was 1,901 gallons per tractor. Those burning only gasoline averaged 2,082 gallons per tractor per year. Those burning kerosene averaged 807 gallons of kerosene per year and, in addition, 742 gallons of gasoline. The operators using distillate consumed an average of 1,208 gallons of distillate per tractor per year and also 611 gallons of gasoline. Gasoline made up 79.3 per cent by volume of the fuel consumed annually by the tractors covered in this study. Distillate accounts for 16.6 per cent and kerosene 4.1 per cent.

The average number of days use—number of 10-hour days requested—reported by the tractor owners was 82 days. The tractors in which gasoline was used as fuel averaged 83 days per year and those in which distillate was used were also operated an average of 83 days. The operators using kerosene reported 71 days use per year.

In answer to the question, "On which fuel does your tractor operate best?" 77.2 per cent reported in favor of gasoline, 16.4 per cent for distillate, and 6.4 for kerosene.

The prices paid for the various fuels are reported in Table 2.

TABLE 2. FUEL PRICES IN CENTS PER GALLON (1932-1935)

Fuel	Number reporting	Highest price	Lowest price	Average price
Regular grade gasoline	204	16.50	5.80	10.10
Low-grade gasoline	596	13.50	5.00	8.58
Kerosene	94	10.20	5.00	7.50
Distillate	263	8.00	3.20	6.04

Several oil refineries are located in or near the center of tractor population in Kansas. Many large operators are able to buy gasoline in tank lots at low prices direct from the plants. This accounts for the low prices paid for gasoline and no doubt has much to do with the importance of gasoline as a tractor fuel in this state.

In the survey the tractor operators were asked for their reasons for using a particular fuel. Reasons were stated in several different ways, but it was found that all could be included under twenty-seven general statements. Many tractor owners reported two or more reasons. The following is a list of the reasons, as stated by the operators, in the numerical order of their importance:

REASONS FOR BURNING GASOLINE REPORTED BY 623 OPERATORS

Cheaper or cheapest in the long run	169
Quicker, easier, or less trouble starting	122
Less dilution of crankcase oil	105
Less oil required	72
Fewer repairs required	70
Engine runs smoother and performs better	55
Less trouble	48
Engine equipped to burn gasoline	42
More convenient to handle	39
Forms less carbon in engine	37
Better for tractor	36
Engine develops more power	35
Engine runs cooler	32
More satisfactory	29
Less wear on engine parts	26
Tractor will last longer	25
Cleaner to handle	22
Better service from tractor	17
Engine gives more flexible power	14
Keeps tractor cleaner	13
Recommended for tractor by manufacturer	11
Engine idles better	9
Engine knocks less	5
Less exhaust fumes	3

REASONS FOR BURNING KEROSENE REPORTED BY 65 OPERATORS

Engine develops more power	28
Cheaper	25
Smoother and better performance	6
Engine equipped for kerosene	5
Goes further or uses less fuel	4
Recommended for tractor by manufacturer	3
Engine runs cooler	3
Less exhaust fumes than from distillate	2
More satisfactory	2
Less trouble than distillate	1
More convenient to handle	1

REASONS FOR BURNING DISTILLATE REPORTED BY 210 OPERATORS

Cheaper	155
More power from engine	87
Goes farther or uses less fuel	44
More satisfactory	8
Engine equipped to burn distillate	7
Engine performs better	6
Recommended for tractor by manufacturer	5
Engine runs cooler	5
Engine uses less oil	2
Safer to handle	2
Less fuel lost by evaporation	2

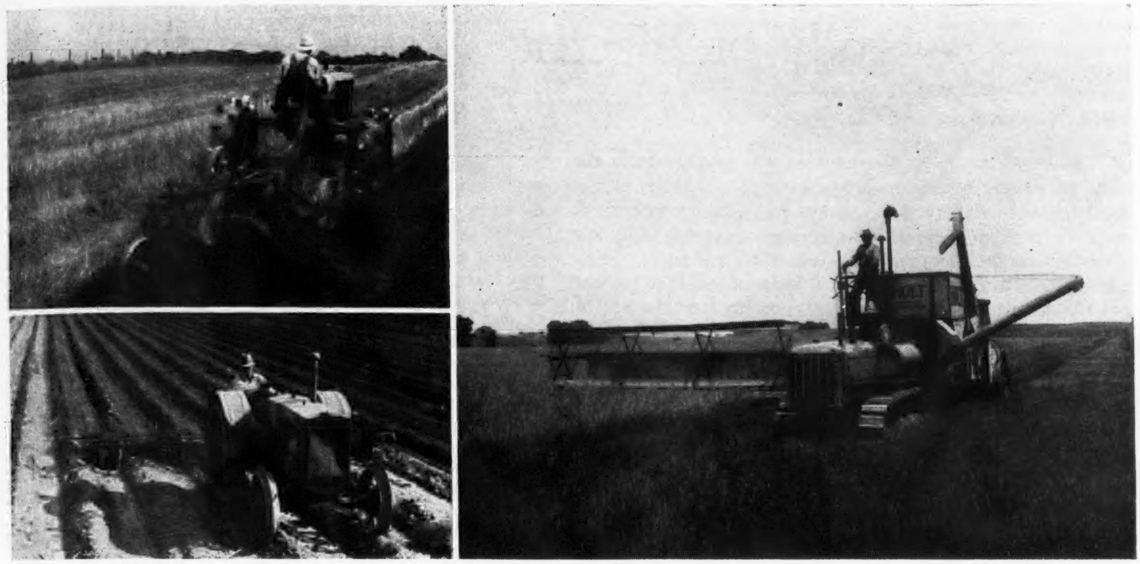
The statement was made frequently by tractor owners that a considerable saving in oil was possible when gasoline was used instead of the lower grade fuels. "Less oil required" ranked fourth in the reasons given for burning gasoline. In each case the tractor operator canvassed reported his yearly oil consumption. The grand average was 66.5 gallons per tractor per year, or 0.82 gallon per day.

Table 3 shows that there is slightly more oil consumed when the low-grade fuels are used, but it cannot be said that the increase is of great significance.

TABLE 3. OIL CONSUMPTION OF TRACTORS USING VARIOUS FUELS

Fuel used	Number reporting	Average number of days per year operated	Average gallons of oil per year	Average gallons of oil per day
Gasoline	596	83	65.7	0.79
Kerosene and gasoline	85	71	62.1	.87
Distillate and gasoline	219	83	70.4	.85

The time between crankcase drainings for 591 tractors burning gasoline averaged 52.7 hours; for 80 kerosene-burning tractors, 52.6 hours; and 217 distillate-burning tractors, 49.1 hours.



THREE TYPES OF FARM TRACTORS. THE DRAWBAR HORSEPOWER OF TRACTORS IN KANSAS IS GREATER THAN THE POWER OF HORSES AND MULES OF WORKING AGE IN THE STATE. TRACTOR FUEL COSTS KANSAS FARMERS ABOUT $10,000,000 PER YEAR

Each tractor owner was asked to state the number of years his tractor had been operated and also to make an estimate of the number of years it could be expected to give service in the future. The combining of these two gave an estimate of the total life of the tractor. At another place in the survey form the operator was asked to estimate the total years service that could be expected of a tractor such as he owned and under his conditions. Thus the operator was given two opportunities to estimate the total years life of his tractor. By the first method the average estimated life of all of the tractors included in the survey was 11.1 years. The second method gave an average of 11.4 years.

Common among the reasons stated for using gasoline as fuel were "better for tractor," "less wear on engine," and "tractor will last longer." If it were an unquestionable fact that gasoline-burning tractors last longer, it is believed it would be reflected in the estimates of total years service life. However, no significant difference in estimated life of tractors when burning different fuels was found, as will be seen in Table 4 which gives the average estimated life of the tractors using each fuel.

TABLE 4. ESTIMATED LIFE OF TRACTORS USING VARIOUS FUELS

Fuel used	Number reporting	Average estimated total life	Average estimated life. Age plus expected future service
Gasoline	547	11.0	11.0
Kerosene and gasoline	78	12.3	11.9
Distillate and gasoline	223	11.4	10.8

Another important point among the reasons given for preferring a certain fuel, on which data could be obtained, was repair costs. It was found that 51.3 per cent of the tractor owners kept cost and service records and could give exact repair costs. The remainder or 48.7 per cent furnished estimates. The exact repair costs were available to a greater extent on tractors less than six years old and estimated repair costs came more generally from the owners of the older tractors. For the purposes of this study the exact and estimated figures are combined. Table 5 gives a brief summary of the repair cost data.

TABLE 5. TRACTOR REPAIR COSTS WITH THE VARIOUS FUELS

Fuel used	Number reporting	Average age of tractor	Total years of service represented	Average repair cost per year of service
Gasoline	545	4.73	2578	$21.90
Kerosene and gasoline	74	5.16	382	16.36
Distillate and gasoline	223	4.66	1040	17.17
All	842	4.75	4000	20.14

The tractors in each fuel group in Table 5 do not represent equal numbers of the same makes or models of tractors nor tractors of the same age. To eliminate, if possible, the influence of makes, models and ages in the repair cost comparison, the tractors were divided so there would be in each fuel group the identical numbers, makes, and ages of tractors. Table 6 gives results of this comparison:

TABLE 6. TRACTOR REPAIR COSTS WITH VARIOUS FUELS (selected group)

Fuel	Number in group	Average age of tractors	Total years of service represented	Average repairs cost per year of service
Gasoline	47	4.85	228	$16.26
Kerosene and gasoline	47	4.85	228	11.57
Gasoline	77	4.49	346	$16.74
Distillate and gasoline	77	4.49	346	16.94

These data are not intended to prove that the low-grade fuels are more, or less harmful to the tractor engine. They simply indicate that possibly many of the statements and opinions of tractor operators about higher maintenance costs when low-grade fuels are used, are without foundation.

Much evidence was obtained through contacts with tractor owners in conducting the survey to indicate that the whole fuel problem is poorly understood by the operators. Many theories and ideas of questionable origin prevail. There is a very limited amount of suitable information on the subject available to the tractor operator.

A Study of Electric Water Heaters

By Evelyn H. Roberts

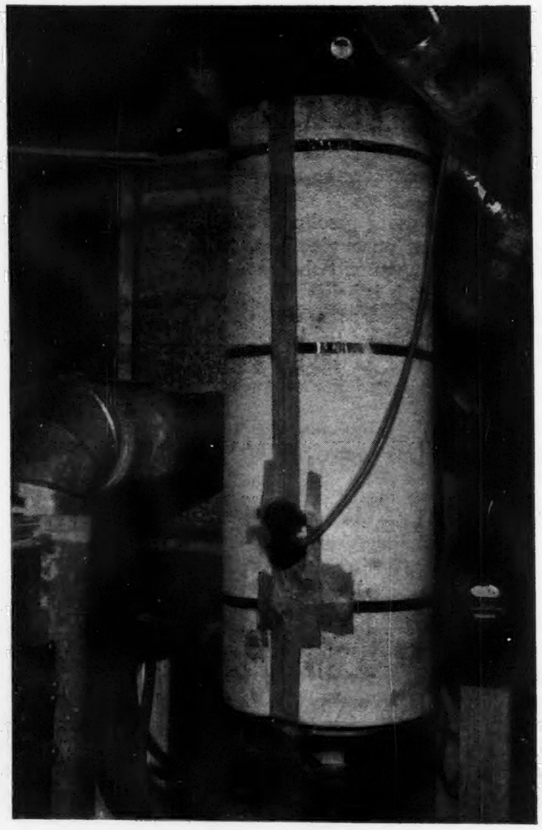
SEVERAL years ago the question was asked, what is the optimum operating temperature for electric water heaters? Rather than attempt experiments on a small scale in a laboratory, information was sought from the manufacturers, utility companies, chemists, and users. From the manufacturers and utilities it was found that present practice in electric water heating tends towards the use of larger, well-insulated tanks, equipped with two heating units, each thermostatically controlled. Present usage involves the installation of more of the storage type heaters, rather than the instantaneous or circulation types. Former practice included the use of storage heaters with small insulated tanks, heated by single units, and some circulation heaters. The 1935 storage heater is metered separately from other household use and is on a special rate, which varies in the Pacific Northwest from 7.5 to 10 mills per kilowatt-hour. An electric clock controls the hours when power is available for heating the tank of water. This time period in the Pacific Northwest is from 8:00 p.m. to 4:00 p.m. of the following day, a 20-hour heating period. This is a decided change from 20 hours of service for which flat rates of $2.50 to $4.00 per month were charged, the cost depending upon the wattage of the heating element. All flat-rate heaters were controlled by an oven switch or a peak limiter.

Opinions vary somewhat as to the needed temperature of the water supplied by modern heating methods. Yet the range of accepted, fixed thermostat settings is not very wide. Table 1 indicates present tendencies. The average of sixteen fixed or average temperatures recorded in this table is 152 degrees (Fahrenheit).

The chemist bases his conclusions for acceptable operating temperatures on the chemical reactions resulting from heating water. The common mineral compounds which make water hard are generally precipitated when water is heated, since the carbon dioxide is evolved and these compounds are no longer soluble. (The heating of soft water does not cause precipitation difficulties.) The deposit is a heat insulator, and more heat has to be supplied to create steam than in a boiler containing no deposits. This problem is not so acute in the domestic water heater. However, the deposit of mineral compounds from water on the interior of a tank and on heating elements can cause trouble in time, as it clogs outlet pipes and slows the heating of the water, and tends to destroy the heating element itself through failure of the heat to be transferred to the water.

Critical studies of the heating of water have shown that at 131 degrees carbon dioxide is first given off. After this gas is forced out, calcium carbonate and magnesium chloride begin to precipitate at 180 degrees. From the result of small-scale experiments, a local engineer claimed 165 degrees as the maximum temperature to which he would heat water in a water tank. Tests by a German scientist on a hard water led him to state that 140 degrees was the maximum temperature to which that water might be heated without deposition of a heavy scale. From these two viewpoints, actual practice, and chemical tests, the maximum feasible temperature for heating hard water is under 180 degrees, and with certain waters lower values may be better.

Nothing has been said so far from the safety standpoint, but that is also worthy of consideration. Installations have been noted during the past few years of insulated electric heaters with no thermostat control, hence, continuous operation of heating units. Steam was often ejected from faucets. Bumping was noted in tanks, and water would have to be run off to lessen the pressure in the tank and lower the hazard. Thermostats set at approximately 150 degrees would eliminate the hazard to equipment and personal users.



THIS SHOWS ONE OF THE ELECTRIC WATER HEATERS UNDER TEST AT STATE COLLEGE OF WASHINGTON

As long as flat rates for water heating prevailed, consumers and utility service men did not concern themselves with the temperature setting of the heater thermostat. But on a metered rate, the cost of maintaining 40 or 52 gallons of water at 180 degrees is higher than maintaining the same amount at 150 degrees. Radiation losses from the tank held at the higher temperature are much greater than those of the tank at the lower figure. Hence, from a cost of operation standpoint, maintenance between 150 and 160 degrees would be the more economical.

Since a lower thermostat setting seemed desirable from usage, for prevention or excessive lime deposits, safety, and cost of operation, the question of whether the

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TABLE 1. RECORDS OF THERMOSTAT SETTINGS OF VARIOUS WATER HEATERS REPORTED BY MANUFACTURERS AND ENGINEERS

Source of data	Temperature, degrees F	Remarks
Manufacturer of gas heater	140	Fixed
" " "	140	"
" " "	135-165	Adjustment
" " "	140	Fixed, lever control
Manufacturer of electric heater	135-150	Adjustment
" " "	120-180	"
" " "	135, 150, 180	"
" " "	170	Fixed
" " "	150	"
" " "	160	"
" " "	120-200	Adjustment
" " "	145	Fixed
Utility company	150	Recommended average
" "	160	Recommended average
Engineer	150	Recommended average
Engineering association	144-146	Average from users
Engineer	184	Fixed in test
Electrical journal	150	Recommended average
Gas journal	135-140	Recommended range
Engineer	160	Recommended average
Engineer	160	Recommended average

Average of 16 fixed thermostats, 152 degrees ± 9 degrees

housewife was getting an adequate supply was next considered. Usage in gallons of hot water varies considerably from day to day. Records of the various utility companies and experimental tests showed that daily usage averaged 35 gallons of water per capita per diem for total water, while that for hot water averaged approximately 12 gallons. Estimates for the latter ran as high as 20 gallons per capita per diem, which is considerably higher than actual data show. These facts suggested the need of manually controlled thermostats, which would enable the housewife to secure a slightly hotter supply of water on needed occasions and lower temperature water, say at 150 degrees, for most of the week.

An analysis of the need of water for household purposes, as far as the temperature was concerned, was made and results are shown in Table 2. All processes involved placing the hands in water, and hence were partly determined by the maximum temperature tolerated, which upon test was approximately 120 degrees. Laundering temperatures were based upon the temperatures suitable for various fabrics, and also upon the fact that albumin is set by temperatures above 158 degrees. Practically all temperatures listed in the table are under 140 degrees, which would be less than the suggested 150 to 160-degree range.

Because of the apparent need of water hotter than 150

TABLE 2. DESIRED TEMPERATURES OF WATER FOR HOUSEHOLD PURPOSES

Purpose	Desired temperature, degrees F	Source of data
Dishwashing by hand	100-120	Laboratory tests
Dishwashing by machine	160	AIEE specifications
Laundering	90-140	Laboratory tests
Bathing	95-103	Home tests
Hand washing	95-115	Home tests

degrees and the possibility of manually controlled thermostats, tests were made in five local homes over a period of four months. The housewives showed considerable interest in the experiment of controlling the temperature of available water. Water meters were placed on the input side of the water heaters which were all manufactured by the same company and practically identical except for capacity. Electric watt-hour meters were connected to the heating units of the tank. A tabular showing of the tests is given in Table 3. Readings were made weekly of the gallons of water heated and the kilowatt-hour usage, but only averages are shown in the table. Calculated values of water and electric power usage per family and per capita are also given for month and day periods. Home No. 4 used a small coal stove as an accessory water heater, and the water meter recorded the total number of gallons heated by both methods, hence the values in this column are slightly different. Home No. 5 was equipped with one of the then new clock-controlled water heaters, on a special meter, and is recorded to show the very slight difference in operating cost. The rate in this case was 8 mills per kilowatt-hour, while the other four heaters were on flat rates. Temperatures were taken weekly, and averages are shown, but they do not indicate a great deal, except that the water supply was quite hot on Tuesday mornings between 9 and 11 o'clock.

From Table 3 the most definite fact is the local cost of heating one gallon of water, which is approximately 2.1 mills. If Home No. 4 is omitted, the average is 2.3 mills per gallon. Heating 60 gallons of water, the amount used per day by a family of five members, at either a flat rate or the 8-mill rate, would involve a daily cost of between 12 and 14 cents.

On the basis of the number of gallons of water heated per kilowatt-hour from these five home tests, it is evident that the set-up in Home No. 5 is the most efficient, with 3.5

TABLE 3. WATER HEATER TESTS IN FIVE HOMES

	No. 1	No. 2	No. 3	No. 4	No. 5	Average
Number in family	6	3	4.5	5	8.5	5.4
Size of tank in gallons	52	52	30	40	40	
Number of heating units	1	1	1	1	2	
Wattage of heating units	1000	705	700	850	1500 (upper) 1000 (lower)	
Rate	flat	flat	flat	flat	8 mill	
Cost per month	\$3.50	\$2.75	\$2.50	\$3.25	\$4.43	\$3.31
Average kilowatt-hour usage per week	152.5	113.0	108.3	163.1	129.0	133.2
Average gallons of hot water heated per week	429	263	268	533	451	389
Average temperature of water, degrees	172	165	172	156	163	166
CALCULATED VALUES						
Kilowatt-hour usage per 30-day month	653	484	464	699	558	571
Gallons per 30-day month	1838	1128	1149	2282	1931	1666
Kilowatt-hour per capita per diem	3.6	5.4	3.4	4.6	2.2	3.8
Gallons per capita per diem	10.2	12.5	8.5	15.2	7.6	10.8
Gallons heated per kilowatt-hour	2.8	2.3	2.5	3.3	3.5	2.9
Kilowatt-hour to heat one gallon	0.35	0.43	0.40	0.30	0.29	0.35
Cost of heating one gallon in mills	1.9	2.4	2.2	1.4	2.7	2.1

gallons per kilowatt-hour. Home No. 4 shows a value of 3.3 gallons heated per kilowatt-hour, but some of the water was heated by the coal stove. The average for the first three homes is 2.5, which is considerably lower than the 3.5 value. Evidently a set-up with two heating units, both thermostatically controlled, is more efficient in the long run than the use of a single unit.

Records for ten homes of three to six members, equipped with the two-unit, clock-controlled electric water heaters were obtained from the local electric company, covering monthly kilowatt-hour usage over periods varying from four to fifteen months. The average used per month per household was 435 kilowatt-hours. The average per capita was 114 kilowatt-hours per month, or the same expressed as kilowatt-hours per capita per diem was 3.8, which value is identical with the similar value in Table 3. The average cost per month of heating the water for these ten homes was $3.48, which is only slightly higher than the $3.31 in Table 3.

The 1936 electric water heater has been developed to meet several present demands and situations. (1) higher wattages to speed up the water-heating process; (2) clock control, to lower household demand for power during peak periods; (3) special meters, to create revenue based on actual usage; (4) lower thermostat settings; and (5) the use of two thermostats on larger tanks to keep operating costs within a reasonable range, and to eliminate hazards due to excessive water temperatures.

Research Procedure

By M. L. Nichols

RECENTLY a committee of the American Society of Agricultural Engineers met in Washington to discuss cooperative relations between industry and the federal agencies conducting research. The committee chairman presented in an able manner the views of the manufacturers which show some very important changes from those ideas which were widespread but a few years ago. The committee's argument, if it can be summed up in a few words, was that the proper activity for state and federal research agencies is fundamental investigation to determine requirements of soils or crops which must be met by machines. Such research will serve as a guide to the designer in the construction of equipment and to the user in making his selections.

If this view were accepted by research workers, their relationship with industry would be clearly delineated. The problem itself must first be carefully considered. It should be part of a real problem faced by farmers of the region or area in which the work is to be conducted. This can only be determined by persons with an intimate knowledge of the agriculture and people of a region. If the problem selected is one in which the farmers themselves are interested it adds greatly to the interest of the worker. There is no substitute for economic or social value in maintaining interest and financial support in the problem attacked. Most important problems are not solved quickly and the worker must be prepared to follow the line he attacks for years, or possibly as a life work. In this way he acquires a broad knowledge and efficiency which only persistent effort can produce. The type of worker who skips from this today to that tomorrow is generally of little importance and has little or no chance ever to become an authority on anything. On the other hand, even the mediocre worker who consistently and systematically pursues any subject will by some queer law of human mentality come to see things clearly in his field. Almost any problem, however complex, can be solved by persistent, patient, diligent, and determined study.

Another important item in research procedure is a careful analysis of the variables or factors entering into the problem. Frequently inexperienced workers devise some contraption such as a dynamometer, then feel they can solve the problems of the universe. A dynamometer is merely a measuring device. Measurments of this kind may be very useful, but as a solution of the problems of plow design, for example, they are merely incidental. The analyses of the causes of draft would lead at once to a study of the soil. If the worker is unprepared to attack such a complicated problem or is unwilling to devote the time necessary for training himself for work in this field, he had better engage in some other endeavor. If he considers it advisable to go on with the problem, the institution with which he is associated should furnish assistance in the person of an agreeable, alert soils specialist who is genuinely interested in this work. Most agricultural problems are of such a complicated nature that the individual has little chance for independent success.

Much emphasis recently has been placed upon a coordinated and cooperative attack. I found it desirable to employ on the research staff attacking problems of soil dynamics and erosion control a mathematician and physicist, a physical chemist, and a mechanical engineer in addition to several agricultural engineers; and required considerable advice from plant physiologists, agronomists, and metallurgists. The combining of men having a wide range of training into the research staff of the Soil Conservation Service and the regionalization of their effort is an excellent illustration of modern methods of research procedure.

The weakest point in agricultural engineering research procedure probably is the insufficiency of attention given to the methods used. Frequently a long period must be spent on methods of research before the direct attack can be made on the main objective itself. Most inexperienced research workers are unwilling to spend much time on developing methods. When correct methods once are established, the results desired frequently can be attained in a comparatively short period. Procedure is often faulty because the worker loses sight of the fundamental purpose of his research as he makes minor discoveries which lead him away from his practical objective. The research worker should avail himself of methods developed in other fields, such as the plot technology developed by years of agronomic experience.

There never was a time when research was so badly needed by agriculture as it is today. Probably the greatest coordinated program ever attempted is now being formulated by the farmers of America in an attempt to develop a sound use of agricultural resources. Any agricultural program that may be developed for the future must be based upon facts, many of which can be obtained only through a greatly increased research program in agricultural engineering.

Presented at a meeting of the Southern Section of the American Society of Agricultural Engineers at Jackson, Miss., February 1936.

Author: Regional engineer, Soil Conservation Service, U. S. Department of Agriculture. Mem. ASAE.

Applying the Fruits of Research

By L. F. Livingston

President, American Society of Agricultural Engineers

THE HISTORY of American agriculture indicates clearly that every advance made by farming has been through technical improvement applied by farmers themselves on their own farms. First, broad-scale mechanization; second, the development and wide use of low-cost commercial fertilizers, improvements in the quality of stock and crops, and, following the World War, the rapid spread of cooperative marketing have been the practical and effective remedies that have solved the great farm crises of the past. By technical betterment, unit costs have been cut time and again and a vanishing profit margin restored.

Today, the farms in trouble, by and large, are those that have failed for one reason or another to make use of what progress has made available. This lack, plus ignorance and error in management, are the roots of our most serious farm difficulties. The very fact that 35 per cent of our farms produce 80 per cent of the total farm income should be abundant proof that the human equation and not dearth of opportunity outweighs any other factor in the national farm problem. Moreover, no program for the general improvement of farming can be successful.

Suppose we do face this fact. Suppose we make the logical division of farmers it warrants, that is, 35 per cent substantially successful and 65 per cent at varying distances the other side of the line. Suppose, too, that we keep in mind the further highly important fact that about the same division might be made of the workers in most other pursuits, not excepting the professions, thus keeping our mental balances even. The situation now becomes simplified to the problem of improving the condition of the 65 per cent, or of at least that portion of them who really desire improvement. And before rushing out to establish new agencies for this work, suppose we glance over the machinery already set up and functioning, apart from that of an emergency and temporary nature.

PUBLICLY MAINTAINED CONSULTING SERVICES AVAILABLE TO ALL FARMERS

At the top is the U. S. Department of Agriculture. This is one of the most important departments of the federal government. Fifteen general officers and seventeen bureau chiefs at an average salary of $7600 per year are needed to administer its complex activities. This is more than the Departments of Commerce and Labor have combined. The U. S. Department of Agriculture has available for distribution, free or at cost of printing, authoritative bulletins on every conceivable phase of farming. Its experts are constantly exploring the world for new things, while it cooperates with state operated experiment stations in every state for studies of specific local problems. This vast service organization stands at the command of the humblest farmer.

It is pertinent to consider briefly the highly personalized sort of assistance given farmers by just one agency of the Department — the Bureau of Agricultural Engineering. Quoting at random from the latest annual report of the Bureau, one finds that during the year nearly 17,000 farmers were aided in procuring better types of machines and using equipment more efficiently. Over 18,000 were trained in adjustment and repair work on nearly 30,000 machines; 31,000 were given expert help in planning 36,000 new buildings, and on 24,000 farms in improving or remodeling old buildings originally designed for the needs of animal power days and poorly adapted to modern uses.

Along with a variety of major research projects ranging from soil erosion control to the development of seed treating and pest control equipment, the Bureau made intimate studies of individual farms over seven states. Among 108 farms of the better type it failed to find one that could not reduce its costs by making changes within the owner's means. In other words, in this single, relatively small agency of government has been accumulated hard facts on farm betterment, which, if they could be made generally applicable, would substantially narrow the gap between agricultural depression and prosperity for some millions of farm owners.

Second in order to the federal agencies we have the state agricultural agencies, the agricultural colleges and experiment stations, and a national network of demonstration and experimental farms. Third in line we have the county agricultural agents, who are within telephone or post card call of every farmer. From one or another of these publicly maintained sources the farmer can, theoretically at will and usually at no cost, obtain the best advice that is to be had on any subject he may name, from planning a 1,000-acre crop program to ridding his hens of lice. No other industry under the sun, no other occupation, no other individual worker has such an abundance of expert aid at his call.

EXTENDING FARMERS USE OF AVAILABLE ADVISORY SERVICES

Perhaps we need better salesmen in the agricultural services. Perhaps these services, comprehensive though they appear, are insufficiently manned. Personally, I know county agents who are attempting to do work that should occupy a half dozen men full time. Perhaps, instead of paying farmers to adopt progressive methods, as a child might be bribed to wash behind his ears and clean his teeth, it would be better economy if we spent that money to establish progressive methods on their merits by doubling or even trebling educational facilities. Surely the benefits would be more lasting.

The really serious trouble, however, in my opinion, is that for a decade and a half we have been systematically discouraging millions of farmers by a propaganda that insists success in farming can begin only in Washington. We have been using black paint on the clouds and looking at the sun with dark glasses. We have been telling the farmer that he is beaten before his plow turns a furrow, that the world he feeds and clothes is united in conspiracy against him, and that if one bogey does not get him another will.

Today agriculture presents a challenge to youth to come and conquer. At no time in its long history has it held brighter promises for the young man of courage, initiative, industry, and brains. We are entering a chemical age that is turning industry's eyes toward the farm as the potential major source of its raw materials. At the same time discoveries in the medical sciences are giving to food,

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An address before the Second Dearborn Conference on Agriculture, Industry, and Science, at Dearborn, Michigan, May 14, 1936.

Author: Manager, agricultural extension section, E. I. du Pont de Nemours and Company. Mem. ASAE.

both as a preventive and curative of disease, an importance undreamed only a decade or two ago. The plant growers of tomorrow may well rank with the physician as one of the vital factors in bettering and maintaining the public health.

Already we can substitute on a crude basis 25 per cent of soy bean oil for linseed oil in paints. But here and there we come upon a batch of soy bean oil that is good enough to permit a 100 per cent substitution—why, nobody now knows. Working with X-ray and ultraviolet light, new factors in such research, scientists hope to get the answer to this riddle, and when they do, there seems to be every reason to believe that plant breeders will be able to produce a variety of soy bean that will consistently yield oil as good or better than linseed.

We are going to produce plants to order. Geneticists confidently make this prediction. Rapid development of the X-ray technique and the mounting knowledge of genes and chromosomes foreshadow the time when the manufacturer will specify the physical or chemical property he desires in his raw material and the plant breeder will create a plant that has it. Just to prove that it could be done, some time ago a plant geneticist crossed two totally unrelated plants. Superficially regarded, the result was a plant monstrosity of no practical use, but actually it was proof to the scientific world that man's skill in the field of plant breeding has reached a point where the most revolutionary developments may be expected.

PROSPECTIVE NEW SOURCES OF FARM POWER

Undoubtedly new sources of cheap power for farms will be developed. By putting cellulose waste such as cornstalks and straw through the same process that is used in treating sewage in a septic tank, the Illinois Agricultural Experiment Station obtained enough gas to operate an engine. Employing old newspapers, peanut hulls, and similar organic wastes in the same process, Virginia Polytechnic Institute secured gas sufficient for all its laboratory and institutional requirements apart from straight heating and lighting. The gas so generated is similar to common illuminating gas.

Power derived from solar energy is yet another possibility that a scientist no less than Prof. Colin G. Fink, of Columbia University, believes is nearer realization than we think. A New Jersey inventor has just patented a refrigerator that utilizes the sun's heat for refrigeration through the evaporation of ammonia. The California and Alabama stations have been able to secure water temperatures of 300 degrees (Fahrenheit) under a well-insulated solar heater. This offers a practical means of supplying hot water for dairy and household purposes.

Most of these power projects are still in their infancy, but they indicate the trend of scientific thought on behalf of the farm and isolated home. More over, the instances I have cited are merely typical and in no sense conclusive of the general effort that is being made to build an agriculture based on science. The point I wish to emphasize is that this effort *is* being made, that enough has been accomplished to convince anyone of vision that we are entering a new phase of agricultural activity that will spell opportunity to those who are prepared for it.

Farmers will have to know infinitely more to produce successfully the crops and to utilize the methods now taking form in the laboratory. They will have to develop a practical knowledge of soil chemistry, of plant pathology, of agricultural engineering, and have at least a basic knowledge of biology. Culture is all important in plant production; environment and feeding are all important in animal breeding and care. Lack of knowledge of a single subject may upset an otherwise sound program.

In dairying, for example, we now know that milk cows may become barren, or the quality of their milk and other products may be seriously impaired, if the moisture content of the soil is not such as to make it possible for the soil to supply just the right amount and form of phosphorus to the forage grown on it. A soil in which the moisture is not properly regulated may mean a surfeit of phosphorus or a deficiency. In either case the normal balance maintained by the animals' sex hormones is likely to be disturbed, even to the extent at times of favoring diseased conditions.

Let me cite another practical instance of how lack of knowledge may affect agricultural income. In 1920, two-thirds of the casein required by American factories was imported simply because they could not get satisfactory casein at home. Engineers, pathologists, animal nutrition men, and geneticists tackled the problem to find out why. The result of their findings and the practical application of these results is that less than four per cent of the casein used in our factories is now imported, and the industrial uses for casein are increasing.

That brings us back to the other serious weakness in our existing agriculture, the lack of knowledge of modern methods that pervades not a few but millions who are seeking a livelihood from the soil. The situation is bad as it is now, but it will be progressively worse if effective education is not a part, and a major part, of any program for the improvement of agriculture through scientific research. Too often in the past we have locked the door after the horse has been stolen—soil erosion is a flagrant example. Let us not repeat past mistakes. For that matter I doubt if the wide use of farm raw materials by industry, which is the major objective of the farm chemurgic movement, can be practically achieved without education as its forerunner. Industry demands not only a dependable supply but dependable quality. It buys where it can buy most economically. This necessitates more economic production and a fine and an intelligent control by the crop producer, in other words, the exact opposite of rule-of-thumb methods.

SCIENTIFIC THOUGHT AND ACTION IN CARRYING SCIENTIFIC KNOWLEDGE THROUGH TO WIDE APPLICATION

Through enormous effort but relatively modest expenditure we have established a national system for agricultural research and education. It has been responsible for most of the progress in agriculture in the past. Without our state colleges, without our county agents, without the work of earnest men in the federal services who have devoted their lives to the betterment of farming in America, without these there would be no mere "farm problem" today—there would be a farm debacle. These services that have proven their worth should be extended, and through them definite steps should be taken to carry knowledge to those farmers who need it most.

Before such an effort can be made on the scale demanded, however, we need more agricultural scientists, more teachers, more agricultural engineers. This type of engineering is vitally needed to translate the discoveries of research into practical on-the-ground action. The shortage in engineering ranks at this moment is dramatically indicated by the fact that a Texas college, which last year graduated seventeen men, could have placed ninety-three men in jobs.

Give us, not alone science in agriculture, but also scientific thinking and action in making the fruits of science generally applicable, and the farmers of America will more than take care of their own in competition with the world.

Performance Studies of Small Combines

By W. M. Hurst and W. R. Humphries

THE INVESTIGATIONS on which this report is based were conducted by the Bureau of Agricultural Engineering, U. S. Department of Agriculture, in cooperation with the agricultural engineering departments of the University of Illinois, Purdue University, and the Mississippi Agricultural Experiment Station. Field observations and tests of combines were made, results of which indicate crop, field, and weather conditions; setting and speed of salient parts of the machines; threshing and field losses for small grain and soybeans in Illinois and for soybeans in the Mississippi Delta.

The performance of agricultural implements, especially combines, depends in a large degree upon field and crop conditions and the skill of the operator. A large number of tests made over a long period of time would be required for qualitative analysis. This paper is based on a rather limited number of tests made during the 1935 harvest season and should be considered as a preliminary report. Some rather definite indications are in evidence, however, and it is hoped that the report will be of use to persons interested in the development and use of combines.

The method of procedure in making the tests was the same as used by several state agricultural engineering departments in the past and described in previous reports. For the work in soybeans in the Mississippi Delta region, no thresher was available for rethreshing the straw caught in making blanket tests, so this was done by hand.

The use of rubber tires on tractors and combines and the marked increase in production of soybeans during recent years have given impetus to the development of small combines. Soybean production in the United States has increased from approximately 5 million to 17.75 million bushels between the 1924 and 1934 crops. With low-pressure pneumatic tires, a two-plow tractor seems to have no difficulty normally in operating a power take-off combine with a 5-foot cutter bar at ground speeds up to 5 miles per hour.

THE OPERATING CONDITIONS VARIABLE IN THE TESTS

The 1935 small grain harvest season in Indiana and Illinois was abnormal. In general, the straw was rank, lodged, and the fields badly infested with weeds. The yield was low on many farms and the grain of low test weight. As a result, combines were being used in some instances to salvage the crop, as combines would gather a higher percentage of it than any other available harvester. For these reasons test data on two fields were omitted from the tabulation. With these exceptions fourteen tests were made on eight small combines in harvesting wheat, and six tests on three such machines in oats.

The 1935 soybean harvest season in Illinois might be considered as normal except for frequent rains during the latter part of the season. In the Mississippi Delta area the soybean crop and field conditions were generally favorable for the use of combines. Weeds were not as prolific as usual, plant growth not exceptionally rank, and weather conditions favorable during the early part of the season. Tests were made on twelve small combines in Illinois and on eight in the Mississippi Delta.

Harvesting Wheat. The results of tests made on eight small power take-off combines in wheat show ground speeds ranging from 2.8 to 4.9 miles per hour with an average of 3.75. Threshing losses varied between 1 and 13 per cent with an average of 3.7. These losses compare favorably with those of larger machines equipped with auxiliary engine. Due to wide variation found in fields on which the machines were operating, and to the limited amount of data, close comparisons should not be attempted. It might be stated in this connection, however, that the average ground speed of the large machines approximated 2 miles per hour, and that of the small ones, 3.75, under test conditions in harvesting wheat in 1935. On both types there was approximately twice as much threshed as unthreshed grain with the straw indicating that the threshing unit is, in general, more effective than the separator. A part of this difference may have been due to improper adjustments, but the indications are that in most cases green weeds or finely chopped straw blanketed the chaffer.

Cutter-bar losses were high for all types of machines, due largely to down grain.

Harvesting Oats. Only four small combines were found harvesting oats, and the results of one test were eliminated because of extremely low yield (6 bushels per acre) and the abundance of weeds.

RELATION OF GROUND SPEED TO THRESHING LOSSES

Due to the small number of tests no tabulation of the data was attempted. However, two fields will be mentioned to illustrate the difficulties involved in harvesting at high speed where green weeds are present. In one clean field the straw was erect and the yield fair. Two tests were made. In one case the threshing loss was 1.0 per cent and in the other, 0.8 per cent. The ground speed was 3.2 miles per hour. In the second field the crop was badly lodged, the straw heavy, and the field very weedy. The first test in this field showed a 27.5 per cent threshing loss, approximately 95 per cent of which was from threshed grain. This test was made with the combine traveling 3.4 miles per hour. A second test was made on the same field under the same conditions as the first, but with the machine traveling at 2.7 miles per hour. The reduction in speed from 3.4 to 2.7 miles per hour resulted in a reduction in the threshing loss from 27.5 to 11.6 per cent. Percentage of unthreshed grain in the straw was practically the same in both cases, but at low ground-speed the separator had a chance to shake the grain out and the chaffer was not overloaded quite so badly.

Harvesting Soybeans. Beans were usually found planted in 36 to 42-inch rows on 3 to 5-inch beds in Mississippi. In the majority of cases the small combines harvested two rows, but under extremely adverse conditions one row was taken. The height of plants varied from 12 to 49 inches, depending largely upon varietal characteristics.

The ground speed of the eight small combines tested ranged from 1.4 to 5.1 miles per hour, with an average of 3. Two-plow tractors were used in the majority of cases.

Presented before the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 2, 1935.

Authors: Respectively, associate agricultural engineer (Assoc. Mem. ASAE), and chief engineering aide, Bureau of Agricultural Engineering, U. S. Department of Agriculture.

Threshing losses ranged between 0.6 and 7.2 per cent with an average of 3.9 for the small machines. So far as the data show, there was no significant difference in the quantity of threshed and unthreshed beans thrown out with the chaff and straw as was the case with wheat. High losses of unthreshed beans were in most cases in fields where the plants were tough and the beans of high moisture content. Cutter-bar losses were high, ranging from 2.7 to 22.8 per cent, averaging 13.1. In some cases of high cutter-bar losses, shattering had occurred before harvest, or the cutter bar was operated high enough from the ground to leave beans on the stubble. Plants thrown over by the reel were also a source of considerable loss.

ANALYSIS OF BEANS THRESHED FOR MOISTURE AND SPLITS

Results of physical analyses made of samples of beans taken from each of the small machines show moistures ranging from 7.5 to 19.3, with an average of 12.9 per cent. Splits varied from 0.1 to 4.0 per cent, with an average of 1.6. A high percentage of splits, as would be expected, was usually associated with low-moisture beans. High moisture in the beans was due in some cases to starting the machine too early in the season, but in most instances to rain, dews, or high atmospheric humidity. Splits, as well as cutter-bar and threshing losses on the small machines, compared favorably with results obtained with large ones. Close comparison was not attempted due to the limited amount of data obtained. It is possible, however, to harvest beans successfully with the small combines in the South on soft ground where two or more tractors would be required to pull a heavy machine of conventional type, especially if mounted on steel tires.

Duplicate tests were made on each of twelve small power take-off combines and on seven larger ones equipped with auxiliary engines, in harvesting soybeans in Illinois during the 1935 season. The ground speed of the small machines varied between 2.1 and 5.4 miles per hour, with an average of 3.7. The large ones varied between 2.4 and 4.3 miles per hour, with an average of 3.3.

Threshing losses for the small machines averaged approximately 1.2, and for the large ones, 3.9 per cent. Cutter-bar losses were practically the same for the two types. Results of analyses made of samples of beans taken from each machine show little difference in the quality of the beans harvested with large and with small machines, except for splits. For the small machines the splits averaged 7.2 per cent and for the large ones 2.7 per cent. The maximum limit of splits for U. S. Grade No. 1 is 1 per cent and the maximum for U. S. Grade No. 2 is 10 per cent.

The effect of machine adjustment and crop condition on losses and splits is well illustrated in comparing results of tests made in harvesting beans in Mississippi with those in Illinois. In Mississippi all small machines were found operating with the concave teeth or bars removed and with high cylinder speed. The bean plants were tough and green weeds were prevalent in many fields. With these adjustments threshing was accomplished by the flailing action of the cylinder, and few of the beans were split, less than 1 per cent in some cases. Clogging was also reduced to a minimum, and the weeds as well as bean plants passed through the machine without being broken into small pieces.

In Illinois all small machines tested had the concaves in; were operated with a fairly high cylinder speed, and generally in clean fields. As a result, some cracking occurred but threshing losses were as low as would be expected from a stationary thresher, less than 1 per cent in many cases.

The importance of machine adjustment is further illustrated in tests made with a 12-foot combine in harvesting soybeans in Mississippi. Tests made on this machine showed that over 18 per cent of the harvested crop was thrown out with the straw and approximately 14 per cent of the remaining beans split. The cylinder speed was approximately 890 revolutions per minute, two rows of concave teeth were used, and the separator apparently adjusted for oats. By proper adjustments the threshing loss was reduced from 18.1 to 1.1 per cent and splits from 14.2 to 0.5 per cent.

CONCLUSIONS

1 No evidence is available indicating relation between the width of cut of a combine and threshing losses or quality of the threshed grain.

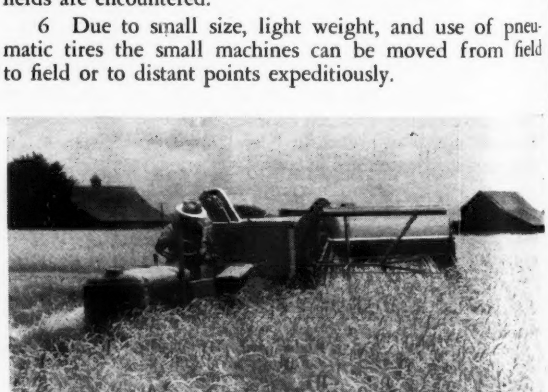
2 Adjustments and condition of the crop influence threshing losses and quality of the grain to a greater extent than the size or type of combine.

3 The quantity of threshed grain thrown over with the straw is usually higher than the unthreshed grain with both small and large machines.

4 A two-plow tractor in good mechanical condition seems to have no difficulty in operating a power take-off combine with a cutter-bar width of about 5 feet, at ground speeds up to 5 miles per hour, the maximum speed of machines on which observations have been made.

5 Small combines on which observations were made can be operated successfully at a speed of 5 miles per hour when crop and field conditions are favorable, but may throw over an excessive quantity of threshed grain with the straw at such speeds when badly lodged and weedy fields are encountered.

6 Due to small size, light weight, and use of pneumatic tires the small machines can be moved from field to field or to distant points expeditiously.



RESULTS OF TESTS OF SMALL COMBINES SUGGEST THAT THE DIRECTION OF FURTHUR DEVELOPMENT MAY BE TOWARD IMPROVEMENT OF THE SEPARATOR AND ADAPTATION TO A WIDER VARIETY OF CROP CONDITIONS, WITH SIMPLIFIED ADJUSTMENTS EASILY UNDERSTOOD AND APPLIED BY THE OPERATOR TO MAINTAIN EFFICIENT OPERATION IN SPITE OF CHANGING CONDITIONS

Possibilities of Rural Resettlement in Wisconsin

By W. A. Rowlands

A RESETTLEMENT program is of more than passing interest to the people of Wisconsin. It is a vital part of a comprehensive land program that provides for a more profitable use of our land resources on the one hand; and a new opportunity for isolated, stranded settlers on the other. Such a program will require many years to complete. It will require enlightened leadership and local support.

Throughout much of northern Wisconsin and also Michigan and Minnesota there are many isolated settlers now chained by the barrenness of their environment to a life of destitution and despair. Located as they are, inside areas of cut-over and non-agricultural lands, they can never hope to have the benefit of neighbors or the conveniences that go with compact agricultural communities. In most cases, the lands surrounding them are already in established forests on which much forest improvement work has already been done.

The cost of providing these settlers with roads, schools, and public health services is out of all proportion to their contribution in taxes. Under the financial condition of many of our northern counties such services become impossible.

The chief interest, therefore, of northern Wisconsin people is in a relocation program that gives these settlers an opportunity to trade their isolated holdings for productive land located in established agricultural communities. County officials are concerned with the relocation of settlers already established on land within their borders, rather than a resettlement program involving the movement of men and families from metropolitan areas to new rural lands.

RURAL ZONING ESSENTIAL TO A RESETTLEMENT PROGRAM

For ten years many state and county agencies in Wisconsin have cooperated in building the fundamental framework on which a positive resettlement program may be developed. Manifestly, the most significant step taken by northern Wisconsin counties has been the segregation of the isolated, the tax-delinquent, and the nonagricultural lands into restricted forestry and recreation districts under county zoning ordinances.

County boards of supervisors were interested in protecting property owners from increases in taxes as a result of unregulated settlement and development of the land. They know that fat cities do not grow on lean country sides. They know too that isolated families located on land too lean for efficient production do not make effective contributions to local treasuries. They were faced with a new problem involving the ownership and management of hundreds of thousands of acres of tax-reverted land. To them it was futile to go to the expense of relocating isolated settlers without some assurance that no new settlers would come into such regions and again cause unnecessary burdens on local government. Rural zoning offered such assurance. In addition, it provided a firm foundation for a controlled and orderly development of natural resources for their highest use.

Presented before the Soil and Water Conservation Division of the American Society of Agricultural Engineers at Chicago, December 4, 1935.

Author: Assistant state leader of county agricultural agents, Wisconsin.

There are now in Wisconsin, twenty-three counties which have enacted rural zoning ordinances and by this means more than five million acres of land have been officially closed to future agricultural development and legal settlement.

The settlers already located in these restricted districts are nonconforming users of land under the ordinances. Since zoning is not retroactive, no change can be made in established settlement. It is to this group of nonconforming users of land that a voluntary resettlement program must be directed.

The good lands, the potential farm lands located in established agricultural communities, were not restricted but left open to unrestricted development and use. Further, Wisconsin county boards have promoted exchanges of undeveloped private lands in the restricted districts for county-owned lands in the unrestricted districts. This has prevented a financial hardship to nonresident owners and has expedited blocking of lands for forestry and recreation purposes.

RESETTLEMENT OF FIRST CONCERN TO LOCAL GOVERNMENT

The enactment of rural zoning ordinances in Wisconsin brought forcibly to the attention of the general public the fact that there are two basic agricultural problems involved in the wise development of northern Wisconsin. These are:

1 The relocation and resettlement of settlers now located on poor agricultural land, and of those who because of location alone are an expense and burden to the community in providing government services.

2 The further development of good land in existing farms and in established farming communities to a point where such settlers will be self-sustaining from the land alone.

In the first case, both relocation and rehabilitation is involved, while in the second, only assistance in rehabilitation is needed.

All units of government in Wisconsin, from the local school district to the state government itself, are financially interested and involved in any plan for the resettlement of isolated settlers. It is the resettlement program that is of first concern to the local government since it holds the promise of immediate savings in public services.

BASIC POLICIES IN RESETTLEMENT

Briefly, the important steps taken in developing a resettlement program in Wisconsin include the following:

1 Establishment of a basic state policy governing all future land use adjustments. In Wisconsin, the land use advisory committee of the state planning board prepared such a policy to guide the several emergency state and federal agencies concerned with resettlement and operating in Wisconsin. This policy emphasized (a) the need for confining relocation work to those settlers now located within the restricted use districts under county zoning ordinances in order to secure the largest return on federal funds; (b) the need for a maximum participation on the part of local government in resettlement work; (c) the need for building into established agricultural communities (infiltration), rather than the development of new communities with consequent high cost for new governmental

services, and (d) the need for definite priority with respect to settlers to be relocated.

2 Determination of the minimum requirements in land and livestock needed to maintain a farm family without outside employment. For the past five years the department of agricultural economics of the University of Wisconsin has conducted studies in dairy and general farm income and expenses in northern Wisconsin counties. The results of these studies indicate that a minimum of from 25 to 40 acres of crop land is needed per farm for subsistence and to provide for repayment of mortgage debts. These figures will, of course, vary with such factors as managerial ability, soil fertility, size of family, market opportunities, and interest rate. In one county 60 per cent of the rural families on relief the past year had less than 20 acres of crop land per farm.

3 The purchase of seven land-breaking units consisting of breaking plows, disks, tractors, and trailers by the Wisconsin Rural Rehabilitation Corporation. In addition, portable gasoline-driven saws and a quantity of smaller hand tools and equipment needed in the development of farms were purchased. Many of the present isolated settlers have wholly inadequate equipment with which to break and prepare new land for crops. In only a few counties are there to be found contractors equipped with machinery designed to do this work. The Wisconsin Rural Rehabilitation Corporation purchased this equipment to use in these localities not at present serviced by land-clearing contractors. The cost for plowing and breaking services is figured on an hourly basis. Total costs will depend on the length of time required to do the job. The best in equipment has been obtained to do this work. A qualified and experienced supervisor, with the help of F. W. Duffee, of the department of agricultural engineering, has selected and trained his crews. This service is now available to rehabilitation clients and will also be used in the development of new farm units for relocation purposes.

4 Definite cooperative relationships have been established between the Wisconsin Industrial Commission and the Wisconsin Rural Resettlement Division. The industrial commission is charged with the enforcement of general orders on explosives for the state of Wisconsin. Only qualified blasters, certified by the industrial commission will be employed in the capacity of blasters on new resettlement projects. Likewise, explosives materials will be purchased from explosive dealers certified by the industrial commission. Mechanical equipment designed for economical stump removal will be considered in the development of the clearing program.

A DEMONSTRATION UNIT FARM PREPARED FOR THE RESETTLEMENT OF ONE FAMILY

The College of Agriculture, department of agricultural engineering, and the Forest Products Laboratory have cooperated in developing log and split-pole types of construction for low-cost houses and farm buildings. An effort has been made to improve the design and construction of these types of structures and to develop the use of a maximum amount of low-cost local material.

A year ago, the rural division of the Wisconsin Emergency Relief Administration arranged for the development of one small farm unit to serve as a demonstration of what could be done in resettlement with the use of relief labor and local materials. The first step in the development of this new farm unit was to secure good land, well located, in an established agricultural community, close to roads, schools, and markets. The question of securing a merchantable title and of establishing the legal boundaries to this land were necessary considerations which, in this case, involved no unnecessary difficulty or delay. Eighty acres of land was purchased in the town of Cassian, Oneida County. The land was located 1.3 miles from the community center where a school, a potato warehouse, railroad, and general stores were established. It was also within 12 miles of the city of Rhinelander. Members of the town board were considered and consulted in the development of all phases of this project. In fact, the reasons why this town was selected as a site for this demonstration were that there were isolated settlers in this town who were anxious to relocate, a town board that was unusually public-spirited, and some good agricultural land in an established agricultural community.

The development of the farm project involved the following necessary work: Erection of a 21x26-foot log house with cellar and outdoor toilet; erection of a 24x30-foot log barn; drilling a 3-inch well; clearing 9 acres of land; brushing 12 acres of land; fencing, landscaping, and surfacing a driveway to house and barn.

Since the time allowed for actual development of the project was short, 12 days, many men were used and practically all operations were carried on simultaneously. The number of men employed on this project varied from 20 to 70 per day, or an average of 50 men for the twelve working days. Organization of the work and selection of the men for the various jobs was the most important managerial difficulty.

The first assignment of men each day was made to construction work on the house and barn. The remainder of the men were distributed cutting, piling, and burning brush, and with subsequent clearing operations. Out of this group of men, from 10 to 20 were selected to work on the house and barn. Some of these were men skilled in mason work, carpenter work, in hewing logs, and in general construction work. In building the log house, the logs were laid horizontally and were chinked with pulp-wood plaster. The larger butt ends of the logs left over after constructing the walls were taken to a nearby prison camp and made into shingles for the roof. A neat stone chimney was built.

After the brush had been removed on about 2 acres, the stumps were blasted, split and loosened ready for subsequent piling and burning. On the second day another crew of 4 men and 2 teams were used to pull and pile the blasted pieces of stumps. All actual blasting work was done before the men came to work, from daylight to 7:30 a.m. and from 5:00 p.m. to dark. With as many men as were working on the project, this safeguard against loss of time and danger was felt necessary.

On the third day a track-type tractor and a 20-inch brush-breaking plow was obtained from the Wisconsin conservation department and the job of plowing begun on the strips already cleared. With the arrival of the tractor and plow, a beginning had been made on all field operations and the need of keeping the brushing crew ahead of the blasting crew, and the stumping crew ahead of the tractor and plow, became increasingly important. Delay in one operation would result in a delay in all other subsequent operations.

On the 9th to 12th days, a group of from three to five older men was employed at levelling and clearing up around the house and barn; trimming the native trees, popple and pine, which were left standing for shelter and shade purposes; and gravelling the driveway. Two large piles, one of popple poles and one of white pine stumps, were provided at the rear of the house ready for use for fuel purposes.

An effort was made to build a warm, substantial yet low-cost house and barn and to provide a maximum of cleared acreage in order to insure the more rapid rehabilitation of the relocated settler. It was felt that the actual labor invested in this project should be used to provide additional cleared acreage since it is out of the cleared land that the settler must secure his income.

It was necessary to use one truck to take the men from the city of Rhinelander to and from work and to use, in addition, one other truck for 4 days. The trucks were used to haul the purchased logs, gravel, sand, and stone for the mason work and water for men, horses and masonry construction.

A plot of about one-third of an acre was disked several times and put in shape for a garden. An additional two acres were seeded to winter rye.

Another area of brushed land of about two acres was fenced with popple poles for use as a night pasture. On the balance of the brushed land a fence was made of cedar poles and three strands of wire.

In the building of the house and in the development of the land all work to be done was not completed. The cellar was excavated under only one-half of the house. The settler to be relocated has been given a start and it is expected that he will complete the balance of the excavation under the house as extra space is needed and he will likewise complete the fencing of the pasture land.

Out of this demonstration much valuable information has been obtained which will be of material help to the Resettlement Administration—the state and the counties in future resettlement work in Wisconsin.

During the past winter, three Wisconsin Emergency Relief Administration logging projects were developed for small crews of men to cut suitable material for use in the construction of new homes on resettlement projects. Enough material was obtained in these three projects to construct from 20 to 25 sets of farm buildings and to do most of the fencing. Lumber for finish flooring and trim was not included in this project.

THE PLACE OF AGRICULTURAL ENGINEERS IN RESETTLEMENT

There are real possibilities in a wisely-planned and directed resettlement program in regions where resettlement is a definite need. It is a practical undertaking and one which will bring important returns in government economy, in public welfare, in citizenship, and in improved morale. The agricultural engineer has an important contribution to make to this movement. The plan of the farmstead; clearing and breaking land for crops; utilization of native materials in the design, and arrangement of buildings for comfort, convenience, permanence, and low-cost; determination of machinery and equipment set-ups for farms of various type and sizes; and the development of land management plans all are definite and direct contributions which we may expect from this professional group. It is both an opportunity and a responsibility to the agricultural engineer.

The Electric Fence

By F. C. Kingsley

THERE seems to be considerable interest among farmers in the development of an electric fencing unit which imposes a pulsating charge on a single-wire fence.

It is claimed by a manufacturer of this unit that this apparatus saves from 50 to 80 per cent in the cost of wire, posts, and braces, and is perfectly safe to operate around livestock.

A number of farmers in northern Illinois have installed electric fencing units which have been operating very satisfactorily. Mr. Kelly of Caledonia, Illinois, has been using one of these fencers for two years. Over 300 rods of fence are energized, some being permanent fence and some temporary fence where only one wire is used, with posts spaced from 3 to 4 rods apart. Two to three wires would have been necessary to keep in Mr. Kelly's cattle, horses, calves, and sheep if the electric fencer had not been used. According to Mr. Kelly, the use of less wire and the saving of time for fencing off temporary pastures during the spring rush, results in a saving equal to the investment in the electric fencer.

Hogs were penned off with satisfactory results with the exception of small pigs. Undoubtedly two wires should be used where hogs and small pigs are pastured together.

Many other users of this fencer are very much enthused over the operation of this apparatus, and tell how effective it is in keeping horses and cattle from reaching or jumping over their fences.

A large stock feeder near Capron, Ill., made a fence charger by connecting a small motor to a magneto and having a 15-watt bulb placed in series with the fence. The wire on the posts had to be insulated with porcelain knobs in order to secure maximum efficiency. About 30 rods of fence were energized effectively. It was stated that the fence need not be charged all the time as the cattle soon learned to respect the one wire.

An article published in the Edison Electric Institute Bulletin gave warning with reference to the safety of using shocking devices on fences. No doubt some of the devices now used on fences may be questionable as to safety. Farmers should be warned regarding the use of homemade devices as the device may break down, thereby connecting the fence directly to the barn wiring circuit.

One manufacturer has made considerable improvement on its unit by adding a 1-ampere fuse in series with the fence, a lightning arrester, and a chopping device which allows the wire to be charged at regular intervals. It was reported by this manufacturer that 2100 units are in use in Wisconsin.

Many farmers are making inquiries regarding the advantages and the disadvantages of this type of fencing. In talking to many of the farmers who are using the electric fencer, the advantages were pointed out to be as follows:

1 Saves time and labor
2 Saves considerable investment in wire and gates
3 One wire may be used in place of a heavy gate
4 Less wire required for fencing fields
5 Keeps livestock from reaching over fence to eat growing crops *(Continued on page 254)*

Presented before the Rural Electric Division of the American Society of Agricultural Engineers, at Chicago, December 4, 1935, as a contribution to the subject "Latest Developments in Rural Electrification."

Author: Rural service engineer, Illinois Northern Utilities Co. Assoc. Mem. ASAE.

Economical Length of Time to Keep a Tractor

By D. G. Williams

TROJAN FARMS in Lehigh County, Pennsylvania, operate as part of their regular equipment two 15-30 four-wheel tractors and two 10-20 general-purpose tractors. We have had eight years of experience with the 15-30 tractors and six years of experience with the 10-20 tractors. We have been attempting to determine at what age each type of tractor should be turned in for a new tractor in order to secure the most economical average operating costs.

We have quite an accurate accounting system in effect on our farms, which covers operating costs for the tractors.

In our method of calculating the age at which a tractor should be turned in, the only two items of cost which have a bearing on this problem are depreciation and maintenance, including repairs. The other items of operating cost, such as wages of operator; cost of gas, oil and grease; garage rental, licenses and insurance, are items which remain constant whether the present or new tractors are in use. There may be some question as to whether the gas, oil, and grease consumption in a relatively new tractor would be as great as in an older tractor. Our actual experience is that there is no increase in the consumption of these materials, and we have had instances where the rates of consumption decreased as the tractor was repaired and kept in first-class condition.

Depreciation is taken here as that actual depreciation established by the trade-in value which the dealer will allow on our tractors, according to his own estimates. For instance, in the case of 10-20 tractors which cost us approximately $1,000 each, the dealer estimates that the trade-in value for tractors maintained in as good condition as ours, will not drop below $350. In the case of the 15-30 tractors, which are not in as general use in our locality, he estimates that the trade-in value will not drop below $250, if the tractors are properly maintained.

TABLE 1. 15-30 TRACTOR

Cost, $1350 each (1000 hours use per year each)

1	2	3	4	5	6	7
				Cumulative Totals		
No. of years of owner ship	Annual depreciation based on turn-in value	Annual repairs and maintenance	Totals of cols. 2 and 3	Depreciation, repairs and maintenance	Hours of use	Average cumulative cost per hour of depreciation and repairs
1	$500.	$ 30.	$530.	$ 530.	1,000	$.530
2	200.	140.	340.	870.	2,000	.435
3	150.	150.	300.	1170.	3,000	.390
4	110.	190.	300.	1470.	4,000	.368
5	80.	160.	240.	1710.	5,000	.342
6	60.	300.	360.	2070.	6,000	.345
7	0	500.	500.	2570.	7,000	.367
8	0	250.	250.	2820.	8,000	.352
9*	0	250.	250.	3070.	9,000	.341
10*	0	300.	300.	3370.	10,000	.337

*Repairs and maintenance cost estimated.

With reference to the repairs and maintenance item, our farms adjoin our manufacturing works, where a regular mechanical servicing department is maintained, in which our tractors receive first-class attention. The repair costs used in our calculations are actual repair costs for those years that we have had the tractors. We have estimated the cost of repairs and maintenance for enough more years in each case to make up a statement for ten years of ownership. We believe that our estimates for repair and maintenance costs for future years have been liberal.

Each of our 15-30 tractors has been used an average of 1,000 hours per year, and each of our 10-20's, 1,500 hours. These are the figures that have been used in Tables 1 and 2, set up to determine the average cumulative cost per hour, of depreciation and repairs.

TABLE 2. 10-20 TRACTOR

Cost, $1000 each (1500 hours use per year each)

1	2	3	4	5	6	7
				Cumulative Totals		
No. of years of owner ship	Annual depreciation based on turn-in value	Annual repairs and maintenance	Totals of cols. 2 and 3	Depreciation, repairs and maintenance	Hours of use	Average cumulative cost per hour of depreciation and repairs
1	$350.	$ 40.	$390.	$ 390.	1,500	$.260
2	100.	125.	225.	615.	3,000	.205
3	50.	150.	200.	815.	4,500	.181
4	50.	260.	310.	1125.	6,000	.188
5	50.	240.	290.	1415.	7,500	.189
6	50.	225.	275.	1690.	9,000	.188
7*	0	250.	250.	1940.	10,500	.185
8*	0	250.	250.	2190.	12,000	.183
9*	0	250.	250.	2440.	13,500	.181
10*	0	250.	250.	2690.	15,000	.179

*Repairs and maintenance cost estimated.

It will be noted from the tables (Column 7) that the 15-30 tractors as we operate them could be turned in any time after the third year for a new tractor without materially affecting the average cumulative cost per hour of operation, and that the 10-20 tractors could be turned in any time after the second year for a new tractor without materially affecting the average cumulative operating cost per hour for this type of tractor.

We prefer to continue to operate the same tractors while they can be kept in proper mechanical condition and still operate at an economical average hourly cost. There is always the possibility of buying a piece of equipment that contains some inherent defect which may give continuous trouble. We believe that when we do secure a first-class piece of equipment that is operating satisfactorily, we should continue it in operation as long as this can be done economically.

The Electric Fence

(Continued from page 253)

6 Reduces weeds along fence by virtue of livestock eating weeds under wire

7 Avoids injury to livestock if run through wire fence as smooth wire may be used instead of barb wire.

The disadvantages are as follows:

1 All livestock are not turned away from fence. This was found true with small pigs

2 Rainstorms tend to ground the system, although this did not prove to be much of a disadvantage as livestock respect the wire if they have had a shock previously

3 Electricity may be off for a short time, thus making equipment ineffective.

"The Effect of Tractor Tire Size on Drawbar Pull and Travel Reduction"

To the Editor:

I DESIRE to amplify my informal discussion of the above-entitled paper by Samuelson, Hurlbut, and Smith at the meeting at which it was presented, and as published in AGRICULTURAL ENGINEERING for April 1936 (vol. 17, no. 4, pp. 143-149), because I think that many readers are likely to draw some conclusions which are not justified by the results reported. Specifically it seems that the statement on page 149, "these data indicate that a change in tire cross-section did not affect traction," needs qualification as to the ground surface and the air pressure used.

In the first place, it may be noted that the tests made July 9, 10, and 11 on the tractor test course were made with different rear axle loads and height of hitch. It is of course permissible to compare the two pressures used on each tire, but if the axle loads and hitch heights were changed much when changing tires, it is not permissible to compare one tire size with another. The hitch height is important because it affects the amount of load transferred from front to rear axle. Care should therefore be used in drawing conclusions from all of the curves on page 145, and from one set of curves on each of pages 146 and 147.

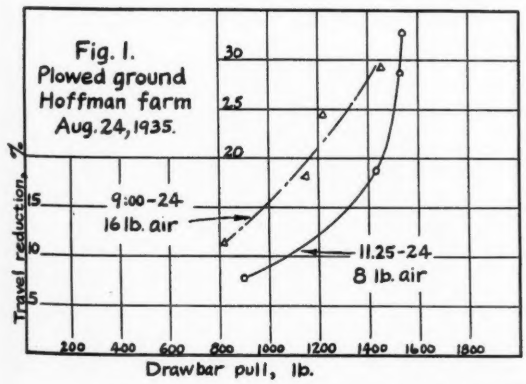
In the second place, it seems of doubtful value to compare the traction of a small cross section with a large one at the same pressure, unless some consideration is given to their load capacity and probable life. For example, the tire manufacturers recommend a 13.5-inch tire for nearly twice as big a load as a 9.00-inch tire at the same pressure. If a 13.5-inch size with 8 pounds of air is suitable for the axle load, then the 9.00-inch size with only 8 pounds of air would be badly overloaded, and its life would probably be much reduced. I understand that the load inflation tables recommended by the tire industry are its judgment as to what will give reasonably satisfactory life. Wide experience with truck and bus balloons has shown that they can have a static deflection of about 13 per cent of the cross section and give good cushioning with life that will satisfy most users. If the deflection is increased beyond 13 per cent by either larger load or by reduced pressure, the greater flexing and heating hasten the time of failure. The lower speeds and larger diameter of tractor tires would seem to permit more deflection for them. Therefore, a deflection of about 20 per cent was used in making load inflation tables for tractor use. The loads given are the static loads and include some allowance for load transfer from front to rear, also for transfer due to side tilt.

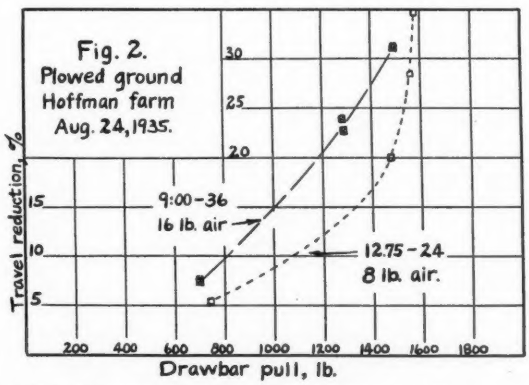
With this item of probable life considered, it is interesting to compare the traction of different sizes, using pressures which will give about the same load capacity. A 9.00x24 tire with 16 pounds pressure has about the same load capacity as a 11.25x24 tire with 8 pounds. I have therefore selected the curves for them on plowed ground from the article in question and compared them in Fig. 1. Similarly Fig. 2 compares a 9.00x36 tire at 16 pounds with a 12.75x24 tire at 8 pounds since they have about the same capacity. These show definitely better traction on plowed ground by the larger cross-section with lower pressure.

For the tractor test course the data seems to indicate that the reverse might be true. The comparison, however, cannot be conclusive because of the varying loads and hitch heights mentioned in tests of July 9, 10, and 11 and because later tests with these factors constant were interfered with by rain.

These and other tests make me wonder if most of us do not have ideas about the traction of rubber tires which may be good only for some particular soil condition rather than of general application. For example, most people have great faith in a deep non-skid design. We have secured results which throw doubt on such faith for some ground conditions at least. In these tests a tire with lugs about $\frac{1}{4}$-inch deep was put on one side of a tractor and newer designs with lugs about $\frac{5}{8}$-inch deep were used on the other side. The load on each wheel was made the same and the travel reduction was compared at different pulls on several surfaces including wet and dry sod and stubble. With this method it is advisable to be sure that each drive-wheel is equally loaded because all tractors are not bilaterally symmetrical.

We were unable to find any conclusive advantage in traction of the deep design, certainly no 30 to 50 per cent as is sometimes advertised. In justice, however, it





COMPARISON OF TIRES OF SIMILAR LOAD CAPACITIES AS TO TRAVEL REDUCTION UNDER VARYING DRAWBAR LOADS

PNEUMATIC TRACTOR TIRE RESEARCH GIVES PROMISE OF ADDING MATERIALLY TO THE KNOWLEDGE FIELD OF TRACTIVE QUALITIES OF MATERIALS AND SURFACES

should be kept in mind that not all soil conditions were tried. No tests were made on sand nor on frozen ground with a thawed slippery surface. It makes us wonder whether a tire does not usually get most of its traction from friction rather than from lugs. At least it seems that a soil can have little shear value when it is soft enough to permit penetration by a rubber lug on a rather soft tire. Public demand may require a deep non-skid design, but possibly it may be better only under specific conditions not yet recognized clearly. A man in the tire industry suggests that, if there is ever any advantage in a so-called non-skid design, it is probably best to have the design deep rather than shallow, since the shallow design will be worn off sooner.

This matter of tread design is mentioned not with the idea of claiming that a smooth tread is as good as a non-skid or lugged tread, but to illustrate the fact that our ideas about traction are not always correct. Probably we all have notions about sizes, pressures, contact area, and non-skid designs which are as yet not well founded on facts. We really know little about the fundamentals of traction of a rubber tire on soil.

Some comment may be added on the horsepower curves on page 149. As E. V. Collins pointed out at the Chicago meeting, the horsepower depends as much on speed as on traction. The speed was probably not the same in the tests since it probably varied with tire diameter. Therefore, it appears that these curves cannot be used to show superiority of one tire over another. They are only useful for showing that the greatest drawbar horsepower is secured by increasing the load until some certain slippage or travel reduction occurs. In general, drawbar horsepower is not a good measure of traction because it includes speed, a variable which is not being studied. Accidental changes in speed will change the horsepower and obscure the effects of the factors being studied.

A. W. CLYDE
Mem. ASAE

Associate professor of agricultural engineering
Pennsylvania State College

Economy Versus Digestibility and Palatability

To the Editor:

DR. G. BOHSTEDT'S paper on feed processing in AGRICULTURAL ENGINEERING for March ably summarized the subject from the point of view of the animal husbandman. To most animal husbandmen, however, the economy of any type of feed processing depends alone on whether the processing increases the digestibility of the feed or decreases the feeding waste enough to offset the cost of processing. From the agricultural engineer's standpoint, the processing of feed may improve neither palatability nor digestibility but still may be economically justified purely as a matter of improving the efficiency with which the feed in question can be handled or housed.

Dr. Bohstedt gives this fact some recognition in the earlier part of his paper but then goes on to make the entirely unqualified statement that "it has not proved economical to chop fine-stemmed, leafy hay for horses and ruminants." As he suggests, with hay of top quality it probably makes little or no difference to a cow or a horse whether its hay comes chopped or unchopped, but storage space in a barn costs money and so does getting the hay into and out of the storage space.

The California agricultural experiment station reports that one variety of whole hay required 480 cubic feet of storage space per ton. The same hay in chopped form required only 170 cubic feet per ton.

An Illinois station release states that with favorable conditions, the cost of harvesting and storing hay in chopped form may be as low as one-half the cost of harvesting and storing whole hay.

Tests at the Iowa station indicate that chopped hay can be stored in 31 per cent less time than long hay, with 33 per cent less labor. Labor at chore time was reduced about 50 per cent when both chopped hay and chopped bedding were available.

Ohio tests showed that chopped hay could be put into storage 37 cents a ton cheaper than whole hay without regard to the two-to-one space advantage of the chopped hay.

When the economy of feed processing is considered on the basis of storage and management in terms of time, labor, and expense, as well as on the basis of digestibility and palatability, it seems apparent that frequently it *will* prove economical to chop even the finest, most leafy hay for both horses and ruminants. Incidentally, that is exactly what is being done on a rapidly increasing number of farms the country over.

FRANK H. HAMLIN
Mem. ASAE

Research department
Papec Machine Company

The Division of Irrigation (BAE, USDA)

This is the fifth of a series of articles prepared by the USDA Bureau of Agricultural Engineering, dealing with the major divisions or activities of the Bureau. The purpose of these articles is to acquaint the agricultural engineering field more thoroughly with the organization, functions, and activities of the Bureau. It is believed that the Bureau would welcome comments on these articles, as well as suggestions from the readers of this journal for improving the services of the Bureau in its particular field. We recommend that such comments and suggestions be addressed to the chief of the Bureau, Mr. S. H. McCrory, in Washington.
—Editor

THE Division of Irrigation (W. W. McLaughlin, chief) of the Bureau of Agricultural Engineering, U. S. Department of Agriculture, is essentially an agency for research into problems of and associated with irrigation and drainage of irrigated lands, but also it is authorized to perform in a limited way semi-extension and service work. It is not an agency for the initiation or building of new irrigation projects, but deals with present and prospective problems of going irrigation enterprises.

The Division is not engaged with the spectacular, such as the building of gigantic dams, great conduits, or the expenditure of vast sums of money, but rather with the more commonplace questions of preserving and improving that which is already existent, feeling that the preserving of a resource by efficient use is just as important, and in some cases more so, than was its original development. The investigation and research work may be prescribed by the Division either alone or in cooperation with public or private agencies or individuals. The greater part of the work is conducted in cooperation with state and with other federal agencies.

To illustrate what is meant by the spectacular and the prosaic, the following will serve. In one area in the West, it is possible to account by actual measurement for only 22 per cent of the water that falls within that area as snow and rain. Of this 22 per cent, about 6 per cent runs directly to waste into the ocean. To conserve a part of this 6 per cent, a reservoir is proposed, costing several millions of dollars. Of the 78 per cent of precipitation that cannot be measured, it is certain that far in excess of 6 per cent is wasted in maturing weed crops. Our investigations show that one acre of weeds will use as much water in a single season as 4 acres of citrus, while one acre of cat-tails will use as much water as 5 acres of alfalfa. The case of the building of the reservoir is the more spectacular, while the control of weed growth is an every day event. Yet the latter offers in this instance the greater prospect of actual value.

The activities of the Division may be segregated into the following grouping of the investigational field:

1 Use of water in irrigation
2 Development and conveyance of water
3 Irrigation and drainage institutions
4 Design and improvement of structures and devices used in irrigation
5 Feasibility and economic studies of irrigation and drainage projects
6 Drainage of irrigated lands
7 Snow cover measurements and irrigation water-supply forecasting.

USE OF WATER IN IRRIGATION

Under this heading, attention is given to losses of water incident to its transportation from the source of supply to the point of use; the requirements of the soils for water; the rate of use and quantity of water needed by the various crop plants; the waste of water by non-useful vegetation; the losses of irrigation water in its application to the field, including deep percolation; methods best suited in applying water; evaporation losses from water and soil surfaces; and such other factors as affect the use and waste of irrigation water from its source to and including its use.

In sandy soils, the seepage loss from canals and ditches is great and the prevention of this loss either by canal lining or the conveyance of the water in an impervious enclosed conduit is an important economic consideration in water conservation.

Methods of applying water to the field, that is, the corrugation method, wild flooding, check border method, etc., may tend to conserve or waste water, depending upon natural soil and topographic conditions, and upon the crop grown. All plants do not use water at the same rate or in the same amount but all plants must have water as needed. Consequently the interval between irrigations, and the total annual requirement is likewise different and these requirements must be determined and met for efficient irrigation. If too much water is applied at a single irrigation, the loss from deep percolation down beyond the reach of plant roots is excessive, and if too little water is applied the plant suffers.

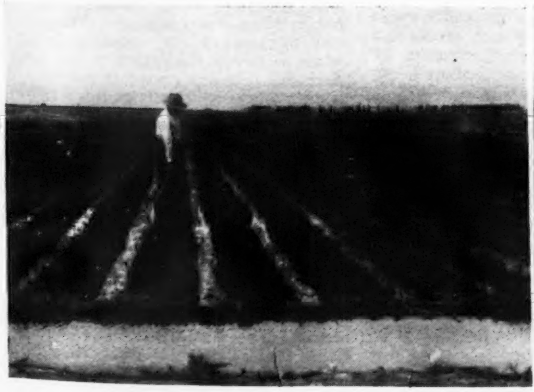
It is found also that the amount of moisture in the soil which in the growing season in the arid region, has its source in irrigation, affects bacterial activity, the physical condition of the soil, and many other things that have an influence upon plant growth. Irrigation is also used for the control of frost and may induce or retard the activity of certain plant diseases and pests. The moisture condition of the soil may affect advantageously or otherwise the food and market value of the agricultural crop grown under these conditions.

DEVELOPMENT AND CONVEYANCE OF WATER

Water is recognized in the arid region as the natural resource having the greatest value, and as development progresses, becomes more scarce and consequently more valuable.

In many parts of the West, water in considerable quantity is to be found beneath the surface of the ground both as artesian and non-artesian. The development of this source of supply is fraught with the danger of overdevelopment, ultimately resulting in either local or widespread catastrophe. Therefore the development of underground water sources affords a field for research investigation that is receiving attention largely from the standpoint of recharge. Frequently, also, there exist springs that through cleaning or other means can be made to yield additional water at points where it can be put to beneficial use. There are numerous sites where small reservoirs could be built either by individuals or by small communities, that would conserve considerable quantities of water that now go to waste. One of the research projects is entitled "Farm Reservoirs." These and other fields are within our investigational domain.

Conduits for the conveyance of water, if not correctly designed, may entail a considerable additional financial burden upon




(LEFT) FURROW IRRIGATION IN IDAHO. (RIGHT) FURROW IRRIGATION OF HEAVY SOIL JUST BEFORE PLANTING COTTON, IN ARIZONA

the irrigation interests charged with the repayment for the building or may be disappointing in the amount of water they will convey. By using as a laboratory, conduits that are already in existence, both old and new, data are developed which have placed the division as a recognized authority in this field. It is important not only that a conduit be designed and built to meet immediate needs but there must be kept in mind effects of time upon the carrying capacity of the conduit.

One of the very important fields of conserving water is by means of underground storage, that is, storage of water within the soil itself. Also, by artificial means, it is possible to augment the natural recharge of these underground reservoirs. The Division is taking the leadership in studying those factors that affect the artificial recharge of underground reservoirs, the possibilities of such storage, and its place in the planning of water utilization. In some areas such as in parts of Los Angeles, San Bernardino, Riverside, and Orange counties, in southern California, three-fourths or more of the irrigation water supply is derived from underground. During the past two years, many hundreds of thousands of dollars have been expended for the purpose of augmenting the natural recharge of these underground reservoirs.

IRRIGATION AND DRAINAGE INSTITUTIONS

Irrigation and drainage work in the arid region is almost wholly dependent upon community and cooperative endeavor. There are very few opportunities where an individual can develop, except through pumping, his own irrigation system. During the past decades various laws have been passed providing for the organization, financing, and development of irrigation and drainage projects. A few of these have been fairly successful in times past, but changing economic conditions are fast making necessary new laws and new organizations not only for the development but for the continuance of irrigation and drainage enterprises. Studies have been made and are being made of existing agencies and those that have fallen by the wayside, to determine the good and bad features of each, with the idea of pointing the way in the further development of these institutions both as to individual and as to community.

Likewise the laws, customs and regulations for acquiring and retaining the right to use water are ever changing or requiring changes due to new circumstances. The laws concerning the use of underground waters are hardly yet in effect. The Division has given much study to these various problems and much investigation remains to be done. *(Continued on page 262)*

WHAT IS NEW
in Agricultural Engineering

FROM THE USDA BUREAU OF AGRICULTURAL ENGINEERING

W. W. McLAUGHLIN attended the fifth annual conference of the Institute of Irrigation Agriculture, at Salt Lake City, Utah, March 11 to 13, inclusive. He was reelected a member of the executive council and appointed chairman of a special committee consisting of a representative from each of 14 western states to prepare a proposed plan for repayment of construction charges on federal reclamation projects.

* * *

W. P. Ireland, superintendent of CCC drainage camp D-6 at Annawan, Ill., has been transferred to Georgetown, Del., as supervisor of camps in Delaware and Eastern Maryland.

* * *

The Bureau of Agricultural Engineering recently entered into an agreement with the National Resources Committee, by the terms of which it becomes associated with the Geological Survey, Bureau of Reclamation, Resettlement Administration, Soil Conservation Service, and the states of Colorado, New Mexico, and Texas, in extensive studies of water supply, needs, and uses in the basin of Rio Grande about Fort Quitman, Texas. The Bureau's activities will center around the mapping of the irrigated and irrigable areas and ascertainment of consumptive use of water in irrigation.

* * *

A vortex tube and sand trap, consisting of a battery of 12 tubes, was designed by R. L. Parshall for installation in the West Side Main Canal of Imperial Irrigation District, California. The trap will be installed in a large flume over New River in Mexico.

* * *

Percolation tests were made by Dean C. Muckel on several ditches on Lytle Creek in Southern California in connection with the project on the underground storage of water. It was found that many ditches which were originally flat-bottomed and shallow have started to erode in a manner which will decrease their wetted area.

* * *

Contributions Invited

It is not intended that the items published under the above heading shall be confined to new developments in the work of the USDA Bureau of Agricultural Engineering. The agricultural engineering departments of the land-grant institutions and other agencies of the federal government are cordially invited to contribute information on recent developments in agricultural engineering for which they may be responsible. It is desired that this feature of AGRICULTURAL ENGINEERING *shall give as complete a thumb-nail sketch as possible of what is new in this field.*
—Editor

The WPA water table survey in the Lower Rio Grande Valley of Texas, sponsored by the state board of water engineers, is progressing rapidly, according to Harry G. Nickle. Over 2,000 test wells have been put down in Willacy, Hidalgo, and Cameron Counties. Levels have been carried to about 1,200 of these, water samples for chemical analysis have been taken from about 150 holes, notes on the soil encountered have been taken on each of the test wells dug, and periodic measurements of wells in each of the areas covered are being taken each month.

* * *

A ridge former has been constructed by E. M. Mervine for preparing sugar beet fields for planting. This implement comprises not only plows which move sufficient soil to form the ridges, but sections of a land roller for firming the ridge. This firming is necessary in some areas because of the lack of winter rains. The ridge former has met with unusual success and may be a feature in establishing a different method of planting in the flat fields where irrigation is difficult.

* * *

R. M. Merrill reports that in an attempt to reduce the construction costs of the self-aligning disk jointer developed as a plow attachment at the Toledo office, a plain tapered bearing has been designed to replace the roller bearings now being used. This plain bearing will be given extensive tests during the coming season.

* * *

According to L. G. Schoenleber the construction of the two-row beet and bean fertilizer hill-drop machine is practically completed. This machine will be used in connection with fertilizer placement studies this spring.

* * *

The Bureau operates a farm building plan exchange and circulates negatives among the cooperating states, from which they make blueprints for distribution to farmers in their own states. A feature of this service is that the title block of the plans for each state bears the name of the state which is an attractive feature on account of the individuality implied.

* * *

W. V. Hukill of the Bureau in cooperation with the Bureau of Plant Industry made a brief study this spring of the control of late blight rot of potatoes in Florida. The potato season was wet and late blight caused losses in transit. Since late blight is most injurious when the surface of the potato is wet it was suggested that the potatoes be given a final washing in warm water to hasten the drying of the surface. A change to warmer weather prevented obtaining conclusive results on this method.

* * *

A paper, entitled "Progress in Ginning Tests and Instruments," was presented by Chas. A. Bennett before the Texas Cotton Ginner's Association at Forth Worth Texas. Mr. Bennett also prepared a paper for the American Society for Testing Materials, entitled "Some Mechanical Elements Involved in Good Ginning."

* * *

A paper, entitled "Crop Production and Seasonal Uses of Water by Some Farm Crops Under Irrigation," was delivered by Leslie Bowen at the annual meeting of the Nebraska Potato Association at Scotts Bluff, Nebraska.

NEWS

Washington News-Letter

from AMERICAN ENGINEERING COUNCIL

ALL of the Washington palliatives have failed so far to make any real dent in the number of unemployed. Estimates of unemployed vary from eight million to fourteen million but the estimators, whether they are on the high side or the low side, have not changed their estimates materially in three years. Statistics on unemployment, of course, are notoriously inadequate, but the broad fact remains that the total number of unemployed today is approximately the same as it was three years ago. Outside of this simple fact, however, the employment situation is full of paradoxes. It is known that there is a definite shortage of skilled help in the building trades in some localities, and if we should have any large advance in the machinery industries, there would be a dearth of skilled mechanics, toolmakers, and other trained craftsmen.

As reported before in this news letter, the government policy, expressed in a nutshell, continues to be a "work-relief" policy under WPA. Many engineers are employed in the government—in PWA and WPA and in some 70 other departments or divisions, but indications are that during the months to come an increasing number of men will be dropped from the government payrolls and among these will be several thousand engineers. It should be fair to prophesy, therefore, that the employment of engineers by the government has reached its peak and that there will be a gradual recession in the number of those so employed. Meanwhile, private employment of engineers is slowly increasing. One of the indexes of this increase is seen in the return of engineers to membership in local and national engineering organizations.

Engineers, however, have more than a personal relation to questions involved in our national re-employment policies. With the return of more normal conditions, the engineer is an employment creator. Re-employment of men in large numbers depends, fundamentally, on the re-employment of capital for the production of new materials, new machines, new buildings, etc. The engineer led and managed capital goods and construction industries still lag behind the so-called consumption goods industries. The fundamental reasons for this lie outside the field of technology and in the realm of finance and economics.

The public must eventually become conscious of the fact that the re-employment of capital underlies the re-employment of men and until our national policies with regard to taxation, federal controls of industry practices and the determination of broad labor policies are settled, the normal processes of re-employment of capital will not take place. Meanwhile, there is an awakened interest in this whole problem outside of government. At the meeting of the U. S. Chamber of Commerce, several phases of the problem of re-employment were presented and a very real stimulus given to the thought that new products, new services and new inventions, all engineer-created products, presented one of the most hopeful opportunities for the re-employment of capital and consequently the re-employment of men.

Under the WPA, $12,000,000 was allotted last December for a study under a National Research Program, entitled "Re-employment Opportunities and the Changes in the Techniques of Production." This study is just getting underway under the direction of Dr. David Weintraub with headquarters at Philadelphia. Some of the factors that are proposed included the measurement of the volume of technological unemployment; changes in productivity in selected groups of industries, and the historical analysis of the development of techniques in relation to the development and standards of living.

There is need of engineering statesmanship in a consideration of this total problem. There is at present no basic statistical data upon which decisions can be made, as to the influence of technology on employment. We are already starting to tax payrolls for social security without knowing yet how many people are employees and how many are employers. It seems evident that if we tax payrolls to provide money for pensions, unemployment insurance, etc., we will reduce payrolls. When this happens, probably someone will decide to tax machine output and we will enter a vicious circle of increased production costs, increased cost to the consumer and a further reduction in the number of employed. American Engineering Council's Committee on the Relation of Consumption, Production and Distribution has expressed the belief that an "economy of abundance must replace an economy of scarcity," to use the latest phrase, if we are to find the answer to a rising standard of living in the United States. Several areas of this whole question can profitably be studied from an engineering viewpoint and it is anticipated that the Committee on Engineering Economics of American Engineering Council will give consideration to some of these questions.

Almost all administrative branches of the government are busy with the execution of programs wholly or partially financed by previous appropriations, but the planning divisions of both regular and emergency agencies are "marking time" until they know more about the purposes and size of appropriations which may come with current legislation. Current appropriations for social programs alone may total close to two and one-half billion, with 1500 million for relief, 370 million for CCC, 40 million for TVA and 200 million for social security. An interesting estimate to be added to a federal deficit accruing at a daily rate of $11,250,000.

According to a recent PWA survey, 83 per cent of elections, held in all but 3 of 3073 counties in 48 states, resulted in popular authorization of bonds to cover 55 per cent of the funds to finance projects for local communities. The other 45 per cent is being provided by grants from the Public Works Administration. All of that wide spread popularity only involved $213,621,592 in contributions to match $150,390,286 in grants, making a total of $364,011,878. In that connection, it is interesting to note that the total is small in comparison with the normal volume. Secretary Ickes reports that over 90 per cent of the projects involved have advertised for bids and that almost 80 per cent of them are under construction or complete. He says that the over-all average cost to the government of giving one man work for one year on the first thousand projects was $741.60. That figure, however, is based upon the old PWA policy of 30 per cent grant instead of the present 45 per cent and does not include any portion of the major cost of projects borne by local communities. There is little to add to press reports regarding the campaign for funds to continue the program of the Public Works Administration, except the observation that unofficial estimates indicate a several hundred million dollar reserve from unexpended appropriations and the possibility of a substantial revolving fund from the sale of bonds, including the profits on same, received in satisfaction of previous loans.

Although the bill for the ten-year program is still in conference, it is expected to pass this session. In the meantime, invitations to bid on the construction of rural electrification projects have been issued by electric service cooperatives and associated private utilities in a number of states; and 20 of the 27 projects on which loan contracts have been executed are, or soon will be, in the construction stage. It also seems that the Rural Electrification Administration is trying to keep the usual channels of trade open for wiring and appliance business in the rural areas. In that connection Mr. Morris L. Cooke predicts "a new era of expansion for the electric trade" and suggests that the "trade will be well advised to give less concern to fears of what the cooperatives may do than to accepting the challenge and going out after new business."

The Civilian Conservation Corps is credited with a surprisingly large amount of work in an official report recently prepared by Director Robert Fechner for the White House. It states that 1,600,000 men and boys have found an average of 8 months' employment in that service. They have worked under the direction of the Departments of War, Interior, and Agriculture in every State in the Union on 17,500,000 acres and have built or repaired 69,000 miles of service roads and trails; 42,000 miles of telephone lines for fire protection and park service; 47,000 miles of fire breaks through forested areas; 2,500 lookout houses; 1,900,000 soil erosion check dams in gullies; 25,000 vehicle bridges and planted 558,000,000 forest trees over denuded areas. All of this is now reported to have an actual value of more than $600,000,000. These figures do no include any attempt to estimate the social and economic value of employment, training and discipline for a large percentage of the youth of this country or the benefit derived from the monthly remittances made by these boys to their families.

With the President's support, Mr. Harry L. Hopkins and his organization now seem almost certain to be entrusted with another billion and a half relief appropriation for

1936-37. It is now scheduled to be included in the deficiency appropriations. No "earmarking" beyond Mr. Hopkins' estimate of over $500,000,000 for roads and the more permanent type of construction is in evidence, but he has promised "a more useful" program. Added to the estimated balance from 1935-36, after all corrections, such an appropriation may total approximately $2,500,000,000 for relief and work-relief at the discretion of the Works Progress Administration.

MEMBER ORGANIZATION ACTIVITIES

Iowa engineering society has initiated a most promising program for the completion of a basic map of that state. They have secured official estimates of the cost of completing the horizontal control system and leveling, and have gotten the estimate included in a bill before the House of Representatives supported by their entire delegation. Their plan is so practical that other states are adopting it and it is entirely possible that sufficient individual state bills may soon be introduced to cause the Congress to recognize the need and provide funds for the final execution of the Temple Act or include the completion of a basic map of the United States in its annual public works programs.

Fourteen technical organizations, including the Washington Society of Engineers and sections of national societies in the District of Columbia have formed a council to consolidate their efforts to render a more effective public service and to unite their contributions to the advancement of their respective professions. They have perfected a strong organization and already have an active group of committees working in a fine spirit of unity.

COUNCIL'S COMMITTEE ACTIVITIES

Organization of all divisions of AEC's committees is complete. Every engineer asked to serve has accepted the responsibility with an eagerness to advance the public's appreciation of the value of engineering judgment, training and experience. Many of the committees have already gone into action and most engineers engaged in the work will be included in programs of committee activities which will soon be ready for distribution. The report of the Committee on Production and Distribution is in the final revision stage and will soon be submitted to member organizations. The Committees on Public Works, and Conservation and Utilization of Natural Resources are completing the first reports of their respective programs. Favorable action has already been taken to support a new Court of Patent Appeals and the Patents Committee is now engaged in the preparation of recommendations for the improvement of patent procedure.

LEGISLATION AND GOVERNMENT REGULATION

Current legislative procedure in the Congress is subject to so much and such rapid change that it is usually inadvisable to attempt definite support of any one piece of legislation until it is favorably reported by the investigating committee for definite consideration. A new bill frequently supersedes the old one before sufficient time elapses to provide for the preparation of a considered opinion. It is our policy to follow all bills affecting engineers and engineering as well as those affording opportunities to act in the public welfare; and with our improved committee organization we hope to be able to present considered opinions to the proper authorities in time for them to be used in connection with the enactment of legislation of that nature.

New government regulations are seldom issued under present conditions, but it is evident that many of them are in preparation, and as soon as the new programs are approved a lot of new rules, regulations, and procedure is likely to become effective. Advance information regarding most of it indicates improvement in the practices of the emergency agencies.

Omnibus Flood Control Bill H.R. 8455 is reported out of committee but it is said to have slim chance of passage. Senator Copeland's S. 4315 declaring "floods constitute a menace to national welfare" and authorizing $5,000,000 for flood control surveys throughout the United States by the Engineers Corps of the Army, is in the hands of the Commerce Committee of the Senate. They have asked the Chief of Engineers for an opinion and propose to report it in time for consideration.

The AEC Public Affairs Committee has made a study of legislation proposed for the creation of a permanent national planning board or the continuation of the National Resources Committee. They are divided in their opinion regarding current legislation, but most of them favor sound planning by a non-political organization under otherwise favorable circumstances. There is no indication that legislation of this nature will pass this session of Congress, but plans are being made for the introduction of a modified and more constructive form of legislation for the same purpose in the Seventy-Fifth Congress. The conception of a national planning board as presented by the National Resources Committee is not understood by many people. In Congress it is still interpreted, primarily, as an agency of the Secretary of the Interior and a "brain trust" engaged in long-range social planning and no immediate practical purpose.

Although the House and Senate have each passed Bills—H.R. 11663 and S. 2512—defining lobbyists and providing for their regulation, neither bill is acceptable to both houses, and it seems likely that the disagreement will prevent either of them from being favorably reported out of conference for action during this session. These bills should not be confused with Senator Wagner's S. 2944 "to prevent and make unlawful the practice of law before government departments, bureaus, commissions and their agencies by those other than duly licensed attorneys-at-law." The Senate Judiciary Committee has reported unfavorably on it, and, therefore, it is dead for this session of Congress.

Irrigation, Drainage Research Group to Meet with ASAE

THE Western Irrigation and Drainage Research Association has voted to hold a meeting at Estes Park in conjunction with the 30th annual ASAE meeting to enable its members to attend both meetings.

Sessions of this group are planned for Wednesday afternoon (June 24) and possibly Friday and Saturday of the same week, to avoid conflict with the ASAE program.

Further information on the program of this group can be obtained from M. R. Lewis or Ralph Parshall during the ASAE meeting.

Personals of ASAE Members

W. D. Hemker joined the new rural electrification department of Westinghouse Electric and Manufacturing Company on May 1, and will be located at East Pittsburgh.

Albert V. Krewatch, assistant in agricultural engineering, extension service, University of Maryland, is author of Bulletin No. 76 recently issued by the extension service of that institution, entitled "Electric Equipment in the Home: Its Care and Repair."

G. E. Ryerson has been transferred to the engineering section of the USDA Soil Conservation Service at Washington, and will be engaged in work on the development of farm and erosion control machinery. His title is "agricultural engineer."

John A. Schaller recently entered the employment of the rural electrification section of the Tennessee Valley Authority. He was formerly a member of the agricultural engineering staff at the University of Wisconsin.

H. B. White is senior author of University of Minnesota Special Bulletin 175, entitled "Farmsteads." It gives brief information on improvements in farm buildings, farmstead layout, and farmstead wiring layout.

Necrology

GEORGE C. D. LENTH, secretary and consulting engineer, Clay Products Association, Chicago, Illinois, passed away May 11, 1936, after a lingering illness. He was a graduate of Massachusetts Institute of Technology in civil engineering, and had been a member of ASAE for the past ten years. Before his connection with the Clay Products Association, he had been city engineer of Chicago.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the May issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Lee E. Baldwin, machine design and experimental work, Cherry-Burrell Corp., Cedar Rapids, Iowa. (Mail) 1620 1st Ave., N.E.

Robert E. Bosque, Box 932, Bryan, Tex.

F. N. Farrington, county agricultural agent, Alabama Extension Service, Dadeville, Ala.

George S. Hossack, 3519 Woolworth Ave., Omaha, Nebr.

Walter S. Marriott, junior administrative assistant, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 109 E. Pleasant St., Mt. Carroll, Ill.

E. F. Ohlendorf, designer, experimental, and development work, John Deere Plow Works, Moline, Ill. (Mail) 816 19th Ave.

V. W. Thalmann, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 1804 Carleton St., Fort Worth, Tex.

TRANSFER OF GRADE

Franklin H. Watson, Jr., agriculturist, East Bay Municipal Utility District. (Mail) Box 61, Lodi, Calif. (Affiliate to Member)

Missouri Student Branch News

THE Missouri Student Branch of ASAE held its annual banquet May 5 at the Sinclair Pennant Hotel. F. B. Mumford, dean of the college of agriculture, and F. Ellis Johnson, dean of the college of engineering, were there and each gave a short address.

Glen Pittenger, president of the Branch, served as toastmaster. Paul Doll, faculty advisor, gave a talk concerning the annual meeting at Estes Park to encourage attendance by the members this year.

A slide rule was presented to Robert Beasley and an ASAE pin to William McCreery for having made the best speeches of the year on technical subjects at Branch meetings. Thirty-two members were present at the banquet.

The Branch held its last meeting of this semester Tuesday night, May 12.

Mr. B. R. Mullen, state technician for ECW, was present and gave a talk explaining in detail the function and activities of the ECW. He showed films illustrating the work which is done by the men in this service.

After this talk there was an election of officers for next semester. Officers elected were: President, Ralph Ricketts; vice-president, Vernon Wood; secretary and treasurer, William McCreery, and scribe, Joe Park.—Joe Park, scribe

Penn State Student Branch News

THE Penn State Student Branch of the American Society of Agricultural Engineers had its most successful year since its organization. It is the purpose of the Branch to obtain successful men in commercial fields to give us a slant on problems which we must face after we graduate. Among the prominent speakers visiting our campus giving us talks were A. P. Yerkes of the International Harvester Company, W. H. Wade of the Penn Central Light & Power Company, and L. J. Fletcher of the Caterpillar Tractor Company, all of whom were elected to honorary membership in the Branch. The Branch now has a unique plan by giving a shingle to its honorary members as a token of their services and good will to the Branch. This now makes three honorary members in the six years since the organization of the Branch. At one Branch meeting over a hundred guests were in attendance.

A trip to the Farm Show, held annually at Harrisburg, is an annual affair. The group makes an inspection of all the farm implements and machinery on exhibit at the show and a dinner is always held at the Y.M.C.A. with representatives of various firms as guests and speakers. The Farm Show corresponds to the State Fair in many other states. The Pennsylvania legislature supplied funds for the construction of a farm show building that covers 8½ acres. This is the largest building of its kind in this country. By having the agricultural exhibit in the winter, it is usually possible for many farmers to attend.

Student Branch interest is also stimulated by having cabin parties in the mountains where girl friends, faculty members and their wives are invited.

The agricultural engineering course is relatively new at this College. Nevertheless, it is of a high standard. This is attested by the fact that practically all the graduates here have obtained employment and this year's seniors are being contacted by commercial firms.—E. Robert Curry, president

Iowa State Branch News

THE first agricultural engineering field day sponsored by the Iowa State Student Branch of ASAE is over. The weather was perfect; the crowd large and interested. Altogether it was a grand success.

Every single demonstration which was put on before the 2500 people present was done to perfection by the students in charge. The exhibits were not of a competitive nature, but they showed the latest developments in modern machinery and engineering methods as applied to agricultural operations.

The faculty of the agricultural engineering department deserves a lot of credit for their splendid cooperation in assisting with the preparation of the program. And, too, without the equipment and advertising contributed by newspapers, magazines, and manufacturing concerns, our field day would not have been the tremendous success that it was.

With the new officers in charge of the weekly meetings, we are carrying on the same instructive program and hear several talks each week on timely agricultural engineering subjects.

Our freshman and sophomore classes are larger than ever and with the prospect of a larger enrollment in the Student Branch next year, we leave our field day behind and look over the horizon to the next step, attending the 30th annual meeting of ASAE at Estes Park.—George H. Dunkelberg, secretary

AGRICULTURAL ENGINEERING FIELD DAY COMMITTEE INSPECTING A TRACTOR TO BE USED IN DEMONSTRATIONS. WELDON O. MURPHY (POINTING), WM. H. MCCONNELL (SEATED), GEORGE DUNKELBERG AND LAWRENCE H. SKROMME (KNEELING), CHAIRMAN.—*Courtesy Iowa Agriculturist*

Virginia Student Branch News

THE Virginia Student Branch held a meeting on April 23, at which time one of the seniors explained the construction and operation of the mercury dynamometer which he uses to test the running power of motors. At this meeting plans were made for an agricultural engineering demonstration for Virginia Tech Day.

On April 30, the Branch met to elect officers for the coming year. The following officers were chosen: President, G. C. Vaughan; vice-president, J. W. Sumner; secretary-treasurer, P. H. Fitzgerald; and scribe, J. G. Craig. After the election of officers one of the students spoke on "The Hesselman Engine."

At the next meeting on May 7, the new officers took over their duties. After this ceremony such topics were discussed as, "Dams to Consume Water" and "Black-Shirt Heaven."

The vice-president presided over the meeting on May 14. A student spoke on "Aerial Surveying" and the president led a very interesting discussion on "Curing Bright Tobacco."

"The Virginia Aggie Engineer" went to press on May 18. This is an annual magazine being published by the Branch this year for the first time. The Branch has as a staff on this publication, J. S. Burgess, editor; A. M. Brown, business manager; and James Lilliard, faculty adviser.

On May 19, the faculty members of the agricultural engineering department invited all members of the Branch to attend a picnic at the agricultural engineering camp at Mill Creek. A large majority of the boys were present and everyone enjoyed the occasion immensely.—J. G. Craig, scribe

Nebraska Student Branch News

THE following speakers and topics were heard during the first semester: Prof. E. E. Brackett, chairman of agricultural engineering, "What's Ahead?"; Wayne Thurman, agricultural engineering senior, "Athens Convention Trip"; Larry Vry, Caterpillar Tractor Company, "Diesel Engines"; Ivan D. Wood, state extension agent in agricultural engineering, "Soil Erosion"; Fred C. Chambers, agricultural engineering senior, "The Pathfinder Irrigation Project"; and Marvin J. Samuelson, agricultural engineering senior, "The Douglas Truck Loading Unit for Testing Tractors."

Officers for the second semester are: Marvin J. Samuelson, president; Pete

Burns, vice-president; and Vernon Keller, secretary-treasurer.

Regular meetings of the Branch are held on the second and fourth Tuesday of each month. We are interested in hearing topics discussed by outside speakers but more and more stress is being placed on the benefits derived from talks presented by the members. The committee in charge of programs consists of Einar S. Dahl, LeRoy V. Girardot and Russell Kyckelhahn.

The following speakers and topics have been heard during the second semester: Clayton Watkins, state director of the Shelterbelt Project, "The Shelterbelt Project"; Prof. E. A. Grone, department of engineering mechanics, "Photography in Engineering"; Prof. C. W. Smith, agricultural engineering department, "What the Boss Wants"; Donald Kuska, agricultural engineering junior, "Streamlining"; Prof. J. E. Krishman, chairman of department of economics, "Your First Investment"; George Hossack, agricultural engineering senior, "Tri-County Irrigation Project."

Social activities are also a part of the work of our organization. Two all-student parties have been sponsored during the past year. These parties ranked with the best of the parties sponsored by any organization this year.

The Nebraska Branch was delegated to write a constitution for the National Student Branch of ASAE. The constitution has been completed and copies have been mailed to the secretary of the Society and to all of the student branches.

The Engineering College sponsors each year, what is known as "Engineers' Open House." At this time all the departments put on a spectacular display. The Student Branch of ASAE put on an interesting display depicting four of the phases of agricultural engineering, namely, rural electrification, farm structures, drainage and reclamation, and farm power and machinery.

Marvin J. Samuelson, president of the Nebraska Branch, was honored by being elected to the Nebraska Alpha Chapter of Sigma Tau. Mr. Samuelson was co-author of a report which appeared in the April issue of AGRICULTURAL ENGINEERING on "The Effect of Tire Size on Drawbar Pull and Travel Reduction." He was also very instrumental in writing the national student branch constitution and was vice-president of the Branch last semester. George Hossack was elected to Sigma Tau in 1934.

The Branch has two of its members represented on the Engineering College magazine editorial staff. Fred Chambers has been general manager at the head of the staff. Emanuel Olson worked with the business manager. Mr. Olson has been appointed business manager for the coming year. George Hossack was business manager of the Blue Print last year.

Two members hold membership in Alpha Zeta, national honorary agricultural fraternity. They are LeRoy V. Girardot and Vernon Keller. Fred Chambers is a member of the Innocents Society, senior men's honorary society. George Petersen is a member of Phi Mu Epsilon, national honorary mathematical fraternity. Four members of the Branch ranked in the upper ten per cent of the Engineering College in their class in scholarship. They are Marvin J. Samuelson, George Petersen, Arthur Larson, and Robert Schluckebeir.

A large delegation from Nebraska is planning to make the trip to Estes Park for the annual meeting of ASAE.—Emanuel Olson, scribe

The Division of Irrigation (BAE, USDA)

(Continued from page 258)

DESIGN AND IMPROVEMENT OF STRUCTURES AND DEVICES USED IN IRRIGATION

Study of this subject is made necessary from the standpoint of permanency of the structures and the scarcity and greater value of irrigation water. Not so much time is devoted to structures at present since the demand is greater for the development of new devices and the improvement of old ones, particularly in the measurement and division of water and the removal of sand, gravel and other debris that otherwise would or does enter the canal. The older devices for measuring water, while reasonably accurate, were in many instances prohibitive for one reason or another. Especially is this true of devices left permanently in the stream or canal or ditch. For instance, the weir is being replaced by the Parshall measuring flume.

As a result of spring floods or torrential storms, many streams whose water is used for irrigation, carry at times large quantities of silt, sand, gravel, and other debris, which if permitted to enter and be conveyed through the canal, are deposited and make necessary frequent cleaning of the canal. The debris barrier as developed in Utah, is designed to prevent the debris from entering the canal. The so-called "sandtrap" is a device developed by the Division in cooperation with the Colorado Agricultural Experiment Station to rid the canal automatically of such debris once it has entered the canal. These examples will illustrate this line of research.

FEASIBILITY AND ECONOMIC STUDIES OF IRRIGATION AND DRAINAGE PROJECTS

The failure of many irrigation undertakings can be traced to faulty economics, engineering, or other factors. Numerous irrigation and drainage projects were instituted immediately following the World War, on the basis of war requirements and war prices. Further, those projects requiring least expenditures in their development, have all been built and there remain the more expensive developments and consequently greater liability of failure, unless the feasibility and economics of the development are carefully weighed.. In this study, the factors that have contributed to the difficulties of other projects are used as a basis. The points of greatest importance are the water supply, the character of the land, the engineering features, settlement, financing or repayment policies, flexibility or non-flexibility of contracts, and all factors affecting the economics of the undertaking. Each development requires a separate analysis.

DRAINAGE OF IRRIGATED LANDS

It seems paradoxical that the arid lands of the West requiring application of irrigation water to produce profitable crops, at the same time need to be artificially drained. Not all irrigated lands need drainage, but a considerable area of them do or will require such treatment. Most of the soils and waters of the West contain some alkali salts, and these salts gradually accumulate at and near the surface of irrigated lands unless sufficient water is applied in irrigation to leach the alkali soils and carry the salts away. The prevalent practice of the irrigation farmer is to apply more water than is alone necessary for the production of crops. If, as is usually the case, the excess water cannot escape through natural underground drainage, there is gradually built up a water table coming nearer and nearer to the surface, and its control by artificial means is necessary. Thus we see in the irrigation picture two conflicting evils, one the accumulation of alkali at and near the soil surface; and the second, a rising water table. Hence drainage is necessary for the control of alkali and for the removal of excess irrigation water.

Frequently the water table receives a part of its supply through seepage losses from canals and through use of excessive quantities of water on the higher and better-drained irrigated areas, resulting in the water-logging and alkalizing of the lands in the lower part of the valleys. In such cases intercepting drains are used rather than the system required in humid areas. The field of research embraces depth of drains, their location, size, protection from the direct inflow of irrigation water, outlet, and all other structures associated with closed drains, and methods of cleaning and maintaining open drains. In the event of relatively large quantities of alkali there may be required cultural treatments with or without chemical applications coupled with leaching and drainage.

SNOW COVER MEASUREMENTS AND IRRIGATION WATER-SUPPLY FORECASTING

This project was authorized by the last Congress and is therefore in its infancy. Its purpose is to make possible the forecasting early in the spring of the irrigation water supply that can be expected throughout the ensuing irrigation season. This forecast permits an intelligent planning of the crop program for the season, thus avoiding the enormous losses in labor and cash outlay for the planting of crops for which there will be no irrigation water later in the season.

Snow, after it has fallen, is nothing more than water in storage, or, as some have stated, "in cold storage," awaiting only the warm weather of spring and summer to release it and make it available for use not only to the irrigationist but also for power, municipal, and other uses. The snow cover is measured before spring melting commences, its water content determined, and based upon records of previous stream flow, converted into seasonal run-off.

Very few of the factors affecting run-off have been subjected to research investigations. The methods used in snow cover measurement and the equipment employed in the measurement of the snow and its conversion into water afford opportunity for improvement. In Utah, for instance, the summer and fall water is derived from snow at elevations of 8,000 feet or more. The area of Utah, which is 8,000 feet or greater in elevation, is only 20 per cent of the total area of the state. The area contributing to the water supply of late fall is very much less. For the reason that the subject is relatively new and that little research has been devoted to it, it affords a worthy field of great promise.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS, 1935, *T. H. MacDonald.* U. S. Dept. Agr., Bur. Pub. Roads Rpt., 1935, pp. 60. In addition to a progress report of the administrative activities of the Bureau, especially as they relate to federal aid and other funds for highway construction, a brief account is given of highway management and production cost studies and of physical researches on highway structures and materials conducted during the year.

RUBBER-TIRED EQUIPMENT FOR FARM MACHINERY, *G. W.* McCuen and E. A. Silver. Ohio Sta. Bul. 556 (1935), pp. 37, figs. 26. Field studies with tractors, farm wagons and trailers, and corn pickers are reported.

The results showed that a tractor equipped with low-pressure pneumatic tires has a lower rolling resistance than one equipped with steel wheels and lugs, and the fuel consumption is less than that of one equipped with steel wheels and lugs at the same relative drawbar pull. Under most conditions rubber-tired equipment on tractors is very satisfactory for plowing or for other farm operations. Rubber tires on tractors are ineffective where moist barnyard manure has been spread over the ground. Under favorable conditions rubber-tired equipment will transmit a greater drawbar horsepower than steel wheel equipment in second or third gear and make it possible to use the tractor for many more jobs which could not be done with steel wheel equipment. The tread of rubber tires does not pick or fill up with surface trash like steel wheels and lugs. Rubber-tired equipment permits higher speeds which generally result in greater fuel economy, and less dust is stirred up by the rubber tires on dry surfaces. With 1,349 hr of use, there has been no evidence of excessive wear on the tires. During that time only two punctures were experienced. Under most conditions a tractor equipped with rubber tires is more comfortable for the operator to ride. The elimination of severe shocks and impacts should give the tractor a much longer life. On all rough and soft tractive surfaces the low pressure rubber tire on wagons required the least draft, whereas on smooth, hard surfaces the steel wheel required the least draft. On cultivated soil or meadow the rubber tire will not "cut in" as deeply as the steel wheel and will not damage meadows as badly as will steel wheels.

The width of rim of steel wheels is a factor in cultivated soil, with the wider rim usually having the advantage in draft. A narrow wheel track usually fills in after the wheel has cut through, making it necessary for the rear wheels to cut a new track.

The roller type of bearing required much less draft than the plain or skein type of bearing. On a cinder road the least draft was recorded at a speed of approximately 8 miles per hour for rubber-tired equipment on wagons. Above that speed the draft increased rapidly. A corn picker equipped with rubber tires required much less draft than the same picker equipped with steel wheels. Much less surface trash was picked up by the rubber tires.

SIMPLIFIED COMPUTATION OF VERTICAL PRESSURES IN ELASTIC FOUNDATIONS, *N. M. Newmark.* Ill. Engin. Expt. Sta. Circ. 24 (1935), pp. 19, figs. 6. From a mathematical analysis of the problem a table is presented giving the vertical pressure on elastic foundations in terms of the intensity of load at a point a unit depth below the corner of a rectangular area uniformly loaded.

GEOLOGY AND GROUND-WATER RESOURCES OF ATASCOSA AND FRIO COUNTIES, TEXAS, *J. T. Lonsdale.* U. S. Geol. Survey, Water-Supply Paper 676 (1935), pp. V + 90, pls. 8, figs. 4. The purpose of this investigation was to determine the source, quantity, and quality of the ground water used for irrigation and other purposes in the above area.

OIL AND GASOLINE INFORMATION FOR MOTORISTS, *G. C. Wilson.* Wis. Engin. Expt. Sta. Bul. 78 (1934), pp. 160, figs. 14. A large amount of both technical and popular information is given relating to gasoline, lubricating oil, and gasoline and oil testing and specifications. Chapters are included on volatility of gasoline, impurities in gasoline, detonation, vapor lock, carburetion and gasoline consumption, special motor fuels, the selection of a motor fuel, the theory of lubrication, lubricating systems, crankcase oil temperatures during the operation, oil consumption, reasons for changing crankcase oil, oil reclamation, selection of oil by the motorist, production of gasoline and lubricating oil, the testing of gasoline, specifications for motor fuels, laboratory oil tests, operating tests of crankcase lubricating oil, and the selection of crankcase oils from specifications. A bibliography of 87 references to work bearing on the subject is included.

SPRAY-RESIDUE REMOVAL FROM APPLES AND OTHER FRUITS, *M. H. Haller, E. Smith,* and *A. L. Ryall.* U. S. Dept. Agr., Farmers' Bul. 1752 (1935), pp. II + 26, figs. 6. This publication, a revision of and superseding an earlier paper, presents recent developments in spray residue removal, particularly with reference to washing media and equipment for fruits sprayed with different materials. Among fruits considered in addition to the apple are pears, peaches, cherries, grapes, and currants. Peaches cannot be treated with hydrochloric acid solutions because of the resulting severe acid injury.

A STUDY OF THE OPERATING RESULTS OF A NUMBER OF SMALL SEWAGE TREATMENT PLANTS, *W. F. Shepard* and *E. F. Eldridge.* Mich. Engin. Expt. Sta. Bul. 63 (1935), pp. 27, figs. 6. Operating data are presented on 20 small sewage treatment plants in Michigan. The study consisted, in most of the plants, in the collection and analysis of two 24-hr composite samples from the influents and effluents of the various units. The units included in the survey consisted of 12 Imhoff tank plants, 3 septic tank plants, 4 plants with separate sedimentation and sludge digestion tanks, 7 sand filter plants, 4 with trickling filters, 2 with contact filters, and 1 activated sludge plant.

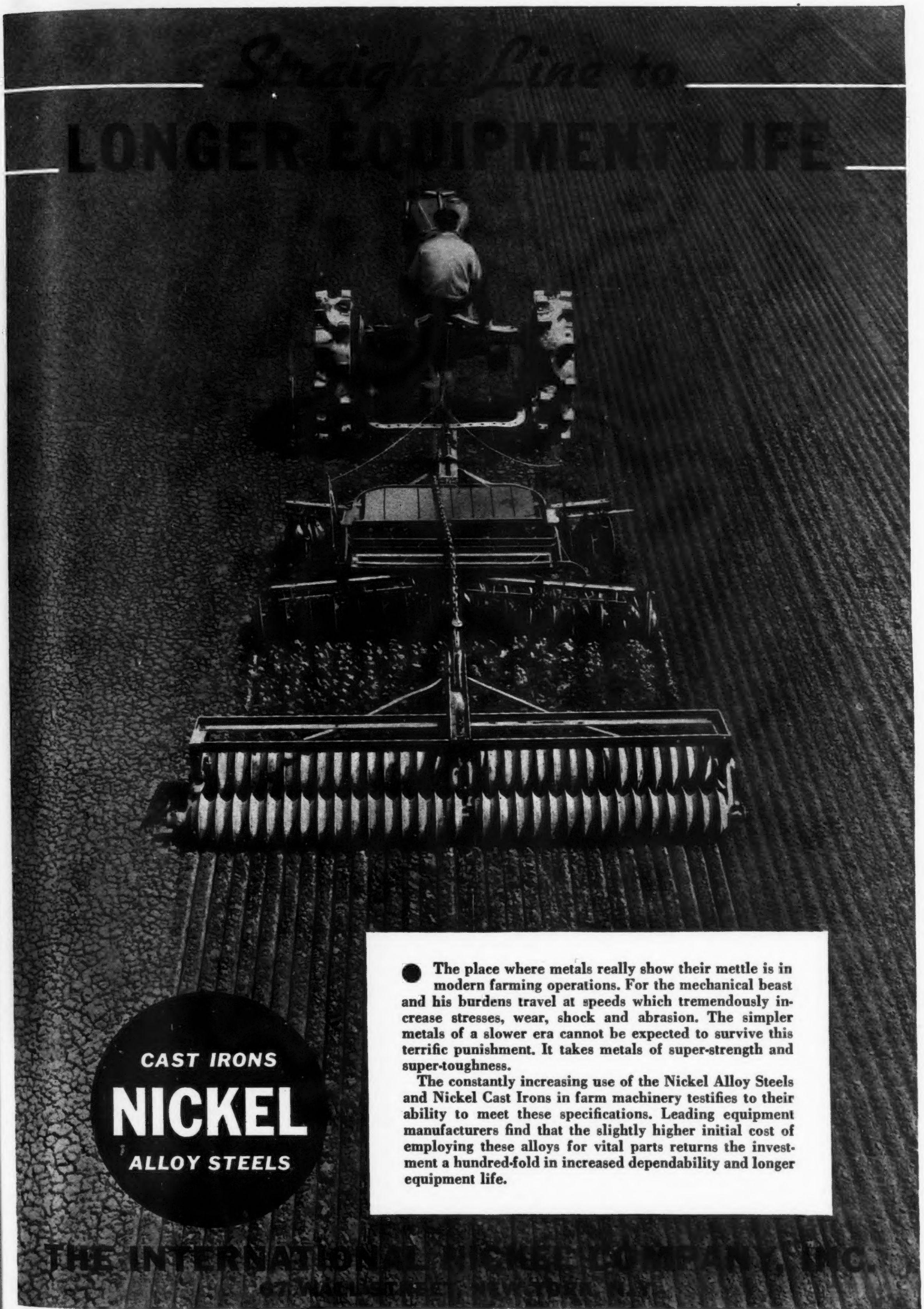
THE ROLE OF FIELD DRAINS IN REMOVING EXCESS WATER FROM THE SOIL: I. SOME OBSERVATIONS ON RATES OF FLOW FROM OUTFALLS, *H. H. Nicholson.* Jour. Agr. Sci. (England), 24 (1934), no. 3, pp. 349-367, figs. 3. In a contribution from the School of Agriculture of Cambridge University, some records of tile drain performance made in 1856-57 are reexamined and the different aspects of drainage in heavy and light soils indicated.

The existence and influence of the movement of the water table in connection with the behavior of light land drains are demonstrated. The problem of the water table in heavy land is discussed, and the behavior of field test holes in such circumstances is explained by surface drainage into them. The magnitude of the fluctuations in runoff from heavy land and the need for closer records of outfall performance are stressed.

Observations on the behavior of mole drains on heavy clay land are described. Comparison of grass and arable land records reveals differences analogous to those between heavy and light land. An account is given of the effects of the advance of the drainage season and of the distribution of rainfall within the season. The nature of the differences in action of tile and mole drains is described.

The effects of variations in the agricultural treatment of one soil type on its drainage properties are indicated. Examples are given of the drying out of the soil and subsoil in the absence of a soil mulch, of the power of surface cultivations to keep the subsoil moist, and of the influence and cultivations in drying out the surface soil, together with their effects on the subsequent drainage history of the area involved.

A COMPARISON OF THE BARGE WITH OTHER METHODS OF HARVESTING WHEAT, *A. G. McCalla, D. Cameron,* and *A. T. Sinclair.* Canad. Jour. Res., 13 (1935), No. 2, Sect. C, pp. 67-78. Samples of Marquis wheat harvested by the barge method in 1932 in the Edmonton, Alberta, district under almost ideal harvest conditions equaled or surpassed in grade and quality those harvested by the binder, swather, or straight-combine methods. In 1933 under more adverse conditions, including considerable rain during harvest, the barge samples were the poorest in grade and baking quality. Some loss of material was due to molding and sprouting in the barge stacks. Bin storage markedly improved the grade and quality of barge samples. Wheat combined at a moisture content of 14 per cent did not heat or gain in moisture content significantly during storage. *(Continued on page 270)*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Agricultural Engineering Digest

(Continued from page 262)

THE WYOMING STRAW-LOFT POULTRY HOUSE, *M. O. North.* Wyoming Sta. Bul. 211 (1935), pp. 15, figs. 6. Practical information is given on the construction of the Wyoming straw-loft poultry house, together with drawings and a list of materials for a 20 by 20-ft section.

Egg production tests are briefly reported indicating the effectiveness of this type of structure for maintaining the producing ability of birds throughout the winter. Other data indicate the insulating ability of the structure.

BOILER-WATER TROUBLES AND TREATMENTS WITH SPECIAL REFERENCE TO PROBLEMS IN WESTERN OREGON, *R. E. Summers.* Oreg. Engin. Expt. Sta. Bul. 5 (1935), pp. 52, figs. 18. This bulletin presents a critical review of what is now established in boiler-water chemistry. The attempt is made to set up briefly in one reference a practical background of established fact for use of boiler operators in any place. Certain peculiar and specific problems encountered in western Oregon are outlined so as to bring them suitably to the attention of boiler users and others concerned.

It is considered apparent that no natural water, regardless of its freedom from hardness, is entirely satisfactory for boiler use without at least some treatment or chemical control. The highly soft natural waters of western Oregon, and perhaps other waters from diverse localities softened to a like degree, are inclined, under the prevailing high boiler temperatures, minimum blowdown rates, and limited boiler-water alkalinities (demanded by metal-embrittlement control), to cause the deposition of very hard, heat-resistant boiler scale of the most objectionable and dangerous type.

1934 TRACTOR COSTS ON 66 MICHIGAN TRACTORS, *K. T. Wright* and *P. F. Aylesworth.* Michigan Sta., 1935, M-148, pp. [1] + 9, figs. 2; abs. in Michigan Sta. Quart. Bul., 18 (1935), no. 1, pp. 49-53. This report is based upon tractor cost records submitted by 63 farmers having 66 tractors. Tables show the annual and hourly costs of operation for different size tractors, by items, the range in hourly costs of two-plow tractors and number of hours used, the use of tractors by operations, relation of tractor used in year to costs and labor efficiency, and size of farm as related to tractor costs and labor efficiency.

THE INFLUENCE OF MACHINE MILKING UPON MILK PRODUCTION, *A. C. Dahlberg.* New York State Sta. Bul. 654 (1935), pp. 16, figs. 3. The data for this study were obtained from cows milked by machine at 2, 3, and 5 years of age and by hand at 4 years for complete lactation periods. Factors such as length of lactation period, length of pregnancy during lactation, dry period, methods of feeding and maangement, age of cows, freedom from disease, methods of operating machines, type of machine, and methods of hand milking were kept reasonably uniform.

The percentage of fat in the milk was not affected by the method of milking. The hand-milked cows produced slightly more milk, but the difference was noticeable only after the third month of lactation. Cows milked by hand were more persistent in maintaining production. This difference was believed to be due to the fact that the machine was left on the cows for a relatively long time and emphasizes the desirability of removing the machine as soon as possible. The results are interpreted to show the need for correct operation of the machines rather than being adverse to their use.

POWER PRUNING, *J. B. Cuno.* Jour. Forestry, 33 (1935), no. 8, pp. 753, 754, fig. 1. The construction and operation of a lightweight, power-driven pole saw developed at the USDA Forest Products Laboratory is discussed.

PRINCIPLES OF SNOW SURVEYING AS APPLIED TO FORECASTING STREAM FLOW, *J. E. Church.* Jour. Agr. Res. [U. S.], 51 (1935), no. 2, pp. 97-130, figs. 10. It is stated that the Nevada or percentage method of snow surveying is for the purpose of forecasting stream flow. This system originated in the Sierra Nevada where the Mount Rose snow sampler and scales were developed by the Nevada Experiment Station for accurately determining water content of snow along a selected snow course. The normal for the season is obtained by dividing the seasonal snow cover by the mean snow cover, or average of all preceding seasons. The discharge of the streams leaving the watershed has been found to bear a direct relationship to the measured water content of the snow. Thus a 75 per cent snow cover on April 1 assures an approximately 75 per cent run-off during April through July. Lack of normal spring precipitation, evaporation, and absorption are minor factors which affect the accuracy of the forecasts, but accuracy within 10 per cent is usually obtainable. Preferred methods of measuring and forecasting and their application to various watersheds comprise the subject matter of this article.

COSTS AND RETURNS AND FACTORS FOR SUCCESS ON TRUCK FARMS IN THE NEW TRUCK AREA OF SOUTH CAROLINA, *B. A. Russell* and *J. L. Fulmer.* South Carolina Sta. Bul. 301 (1935), pp. 64, figs. 10. Records of farm businesses were obtained from 250 farmers, 161 of which were used in all tabulations. In this new truck area, located in the southwestern Coastal Plains of South Carolina and bordering on the Savannah River, 59 per cent of the land is in crops, and of this, 41 per cent is in corn, 39 in cotton, 8 in oats, and 7 per cent in truck.

In favorable years the large farms make the most profits, but in unfavorable years they sustain the heaviest losses. Large farms have an advantage in being able to provide productive work for labor and mules throughout a longer period of time. Farms combining labor efficiency and high rates of production materially strengthen their chances for gain. The farmers that make most profits over a period of time must have above average size of business, crop yields, and labor, mule, and marketing efficiencies.

DIGESTION STUDIES ON GRINDING SNAPPED, EAR, AND SHELLED CORN FOR YEARLING STEERS, *R. R. Thalman* and *R. B. Cathcart.* Nebr. Univ., Anim. Husb. Dept., Cattle Circ. 144 (1934), pp. 16. The above test was supplemented with digestion studies using eight head of similar steers full-fed individually the same rations for 180 days. Three 10-day digestion trials were conducted with these animals using the paired-feeding method. There was little difference between the corn rations within each pair, either from the standpoint of coefficients of digestibility or percentage of ingested corn grain that passed through the digestive tract. The results were not deemed conclusive enough to show the relative feeding value of the rations.

GRINDING SHELLED, EAR, AND SNAPPED CORN FOR YEARLING STEERS, *R. R. Thalman* and *R. B. Cathcart.* Nebr. Univ., Anim. Husb. Dept., Cattle Circ. 143 (1934), pp. 10. Continuing this test, 4 lots of 10 yearling steers each, averaging 671 pounds per head, were fed for 180 days on a basal ration of alfalfa hay. In addition the respective lots received shelled corn, cracked shelled corn, ground ear corn, and ground snapped corn for 80 days, ground ear corn for 60 days, and cracked shelled corn for 40 days. The average daily gains in the respective lots were 2.2, 2.3, 2.5, and 2.4 pounds per head.

While the steers fed cracked corn consumed 2 per cent more corn and 2 per cent less hay and made 3.5 per cent faster gains than those fed whole corn, the differences in efficiency were overcome by the grinding costs. All of the cattle made very efficient use of their feed. The cob and the cob and husk were all about equal in reducing the high requirements per 100 pounds of gain. Steers fed the bulky rations went on full feed more rapidly than those on the more concentrated rations. About twice as much pork was produced in lot 1 as in any other lot.. The market value of the cattle was highest in lot 4, while the carcasses in lot 1 were slightly inferior to those in the other lots.

HARVESTING SOYBEANS FOR HAY, *C. J. Willard, L. E. Thatcher,* and *J. B. Park.* Ohio Sta. Bimo. Bul. 175 (1935), pp. 148-154, figs. 4. Cutting and curing experiments showing trends in yield, protein content, and curing in relation to maturity and weather conditions led to the suggestion that soybean hay ordinarily should be cut by September 1 in northern Ohio and by September 10 in southern Ohio. When cut early in the season in good curing weather, soybeans may be cured most economically if left in the swath until well wilted and then placed with the side delivery rake in small windrows to be turned once or twice. Late in the season, soybean hay usually must be cocked for a satisfactory product, but it should first be cured in swath and windrow as much as the weather permits. Curing soybeans in bundles has been extremely unsatisfactory at the station. Observation trained by experience, is deemed the only practical guide to storing soybean hay, but the beans in the pods must be fairly hard for safe storing.

ORCHARD HEATERS, *L. L. English.* Alabama Sta. Rpt. 1934, p. 26. A brief report is given of trials of heaters and fuels in the Mobile County satsuma orange area.

THE CONSTRUCTION AND OPERATION OF THE MOUND ORCHARD HEATER, *L. L. English.* Alabama Sta. Spec. Circ., Nov. 1934, pp. 11, figs. 7. This heater, constructed of soil and using coke as a fuel, was found satisfactory in the satsuma orchards of southern Alabama.

(Continued on page 272)

Agricultural Engineering Digest

(Continued from page 270)

CONDITIONING OF COLD-STORED FRUIT PRIOR TO RETAIL, *J. Barker* and *C. R. Furlong*. [Gt. Brit.] Dept. Sci. and Indus. Res., Food Invest. Bd. Rpt., 1934, pp. 159, 160. Williams Bon Chretien (Bartlett) pears ripened at 45 degrees Fahrenheit reached only fair quality, with severe losses from scald. With an initial conditioning for three days at 70 degrees fruit ripened in excellent condition. With Beurre Hardy, Kieffer, and Winter Nelis conditioning at 70 degrees made no difference. Kelsey plums did not attain good quality at 47 degrees.

GAS-STORAGE OF APPLES, *F. Kidd* and *C. West*. [Gt. Brit.] Dept. Sci. and Indus. Res. Food Invest. Bd. Rpt., 1934, pp. 103-109, fig. 1. Studies conducted with five varieties of apples, namely, Worcester Pearmain, King Edward VII, Cox Orange Pippin, Bramley Seedling, and Laxton Superb, showed that increasing the carbon dioxide and lowering the oxygen, as compared with ordinary air, had a beneficial effect on the keeping at certain temperatures. However, the varieties differed somewhat in their responses, and the most successful temperatures and atmospheres are indicated not only for the five varieties but also for nine others.

BEHAVIOR OF THREE PICKS OF ELBERTA PEACHES IN RELATION TO TEMPERATURE OF STORAGE, *W. H. Smith* and *Willison*. Canad. Hort. and Home Mag., 58 (1935), no. 9, p. 209. Observations on Elberta peaches at St. Catharines, Ont., on September 2, 6, and 11, showed the advantage of deferred harvesting as related to maximum quality shown in color and flavor. Of three storage temperatures employed, namely, 32, 37, and 45 degrees Fahrenheit, the first was most effective in holding peaches, and fruits harvested in a firm ripe stage kept satisfactorily for from 10 to 14 days. Even at the 45 degree temperature the September 2 lot failed to develop satisfactory dessert quality. More rapid decay of fruits removed from storage than those ripened without storing is believed related to the condensation of water vapor on the cold fruits.

Literature Received

FARM BUILDINGS, by J. C. Wooley, professor and head of the department of agricultural engineering, University of Missouri, is published by the University Co-Operative Store, Columbia, Missouri, with offset printing and paper covers, as one of a series of low-cost texts. In 266 pages it includes 37 chapters and a brief appendix in which "The subject matter is presented with the idea of reviewing the underlying science involved and finding its application to the conditions imposed by the different structures." The author states that the text aims to help students develop ability to think scientifically in the farm structures field. Chapters represent lesson rather than subject matter divisions. They cover history, function, heat, moisture, ventilation, mechanics, design features, specific materials, location and planning of the farmstead, and buildings for special purposes. Figures, 221.

SAE HANDBOOK 1936. Society of Automotive Engineers, Inc., 29 W. 39th St., New York, N. Y. 776 pages, illustrated, 5½x8½ inches cloth bound. $5.00. In this volume SAE publishes all of its currently effective standards and recommended practices, including as changes from its previous volume 5 new specifications, 5 revised specifications and 2 corrected specifications. It also lists ten specifications cancelled since publication of the 1935 volume, and gives up-to-date information on the Society's standards organization, plans and policies. There are 52 more pages than in the 1935 edition.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS WANTED

AGRICULTURAL ENGINEER, graduate of midwestern state university from four-year course in agriculture, and also four-year course in mechanical engineering, desires a change to a broader field of service. Sixteen years' experience teaching agricultural engineering, including most of its branches, but principally farm power and machinery. Teaching, research, or a combination preferred. PW-271